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AIR FORCE

HUMAN RESOURCES

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MATHEMATICAL AND STATISTICAL SOFTWARE INDEX:
SECOND EDITION
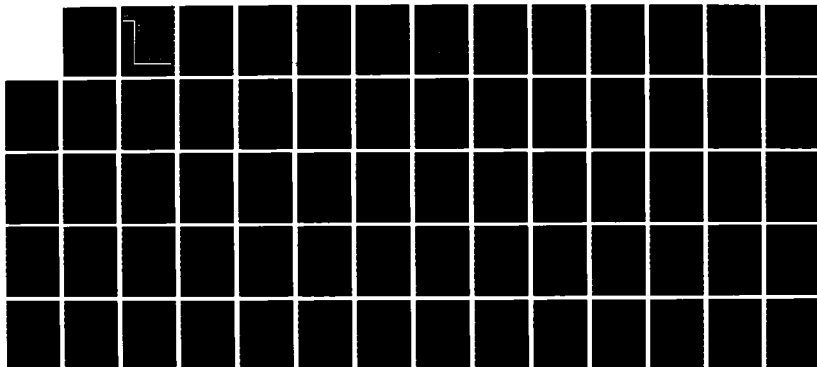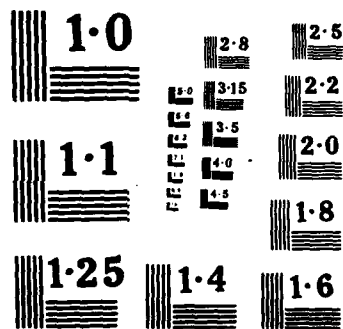
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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This paper is an abridged documentation source for the Air Force Human Resources Laboratory (AFHRL) mathematical and statistical software library for use by Air Force personnel researchers. It provides a single reference which researchers may quickly scan to identify mathematical or statistical computer software that is currently operational and available for use on the AFHRL Sperry 1100/81 computer system. The paper is comprised of four chapters with the first chapter devoted to introductory information; the second chapter, to descriptions of the library's single function computer programs; the third chapter, to descriptions of the library's subroutine systems; and the final chapter, to the nationally recognized statistical packages available in the software library.

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83 APR edition may be used until exhausted.
All other editions are obsolete.

18. (Concluded)

CODAP (comprehensive occupational data analysis)
contingency table
correlation
correlation correction for curtailment of range
cross-classification
cross-tabulation
curve fitting
equipercentile equating
factor analysis
Guttman's technique
hierarchical clustering
interactive regression
item analysis
judgment analysis
linear goal programming
linear programming
linear structual relationships

mathematical computer software
method of reciprocal averages
multidimensional scaling
mutliphase pivoting algorithm
multiple discriminant analysis
multiple-objective model
multivariate analysis of variance
multivariate normal probability
nonhierarchical clustering
nonlinear goal programming
policy capturing
policy specifying
PERSUB
regression
regression equation grouping
statistical computer software
test for normality

MATHEMATICAL AND STATISTICAL SOFTWARE INDEX:
SECOND EDITION

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Chief, Manpower and Force Management Systems Branch
Manpower and Personnel Division

This publication is primarily a reference document. It provides information on the mathematical
or statistical computer software currently operational on the AFHRL computer system.

SUMMARY

One responsibility of the Manpower and Force Management Systems Branch (MOM) of the Manpower and Personnel Division (MO), Air Force Human Resources Laboratory (AFHRL), is to provide a mathematical and statistical software library that can be used in general support of AFHRL research and development (R&D) activities. This responsibility includes evaluating, procuring, writing, developing, testing, modifying, implementing, documenting, and disseminating scientific programming packages, in support of R&D requirements. The software library is available for use by numerous researchers who have access to the AFHRL SPERRY 1100 computer system.

The first edition of the software index contained brief descriptions of mathematical/statistical software maintained by personnel in MOM and in the Technical Services Division (TS). In this edition, the scope of the document has been extended to include descriptions of software maintained by other MO branches and AFHRL divisions. The paper will also bring the user up to date concerning additions/modifications to the software library and documentation due to changes in computer hardware specifications and compilers, identification of errors, and requirements of special problems. Researchers should be able to scan the paper quickly to identify software that satisfies their methodological/computational requirements, enabling research to be accomplished in a much shorter period of time.

The paper is comprised of four chapters, with the first chapter devoted to introductory information; the second chapter, to descriptions of the library's single function computer programs; the third chapter, to descriptions of the library's subroutine systems; and the final chapter, to the nationally recognized statistical packages available in the software library.

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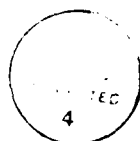
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PREFACE

The Air Force Human Resources Laboratory (AFHRL) mathematical and statistical library, which is maintained on the AFHRL Sperry 1100/81 computer system, undergoes continuous development in support of AFHRL research to facilitate and improve the analysis of human resources data. This paper will expedite the work of Air Force personnel researchers by providing a single reference they may quickly scan to identify mathematical and statistical computer software currently operational on the AFHRL computer system. Work on the software index was accomplished under Project 7719, Force Acquisition and Distribution System; Task 771922, Development of Analytic Methodology for Air Force Personnel Research.

Many people who have worked in the AFHRL Manpower and Personnel Division and Technical Services Division have contributed to the maintenance, development, implementation, and documentation of programs in the AFHRL mathematical and statistical software library. Although those responsible for certain programs are identified in the documentation for those programs, it is appropriate to acknowledge the following key personnel responsible for the ongoing development of the software library: Dr. Janos B. Koplyay, Mr. C. Deene Gott, Mr. Charles R. Rogers, Mr. Jacob E. Myer, Jr., Mr. William J. Phalen, and Ms. Janice Buchhorn. Special acknowledgement also goes to Ms. Doris Black for her commendable efforts in compiling the first edition of the index.

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MATHEMATICAL AND STATISTICAL SOFTWARE INDEX:
SECOND EDITION

I. INTRODUCTION

One responsibility of the Manpower and Force Management Systems Branch (MOM) of the Manpower and Personnel Division (MO), Air Force Human Resources Laboratory (AFHRL), is to provide a mathematical and statistical software library that can be used in general support of AFHRL research and development (R&D) activities. This responsibility includes evaluating, procuring, writing, developing, testing, modifying, implementing, documenting, and disseminating scientific programming packages, as determined by AFHRL R&D requirements. The software library is available for use by numerous researchers who have access to the AFHRL Sperry 1100 computer system.

The first edition of the software index (Black, 1978)[1] contained brief descriptions of mathematical/statistical software maintained by personnel in MOM and in the Technical Services Division (TS). In this edition, the scope of the document has been extended to include descriptions of software maintained by other MO branches and other AFHRL divisions. This paper will also bring the user up to date concerning additions/modifications to the software library and documentation due to changes in computer hardware specifications and compilers, identification of errors, and requirements of special problems. The availability of an up-to-date abridged documentation of library software. has been shown to greatly facilitate and improve the analysis of human resources data associated with AFHRL's personnel and training R&D activities. Researchers should be able to scan the index quickly to identify software that satisfies their methodological/computational requirements, enabling research to be accomplished in a much shorter period of time. Since there is a continual requirement to add new programs or update existing programs and/or documentation to keep the library current, this paper will be updated periodically to reflect these additions/changes.

This paper is organized in a manner similar to the first edition (Black, 1978), as follows: Chapter 2 contains brief descriptions of the "stand-alone" (i.e., single-function) computer programs maintained by system users; Chapter 3 describes the MOM-developed or acquired subroutine systems; and Chapter 4 describes nationally recognized statistical packages resident in AFHRL's computer system.

II. MATHEMATICAL AND STATISTICAL PROGRAMS

The information for each computer program described in this chapter consists of an abstract and references for the user who wishes to obtain the documentation for the program. The abstract presents a general description of the program, the origin of the program if it was obtained from a source outside of AFHRL, limitations of the program (e.g., maximum number of variables permitted), and a warning (if applicable) about excessive computer execution time which might be incurred in certain circumstances. Immediately following the abstract is the organizational designation of the AFHRL office that maintains the program and that should be contacted if the user desires more information. The reference is usually in the form of a technical report/paper or a computerized report available from the Sperry 1100 document processor. A standard format that has been designed for software documentation includes such information as purpose of the program, functions performed, restrictions and limitations, background, control and input data specifications, Sperry 1100 runstreams, descriptions of output

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[1]Black, D.E. (1978). Mathematical and statistical software index (AFHRL-TR-78-66, AD-A062 991). Brooks AFB, TX: Computational Sciences Division, Air Force Human Resources Laboratory.

and interpretations, program messages, references, user programming considerations, computational formulas, source listings, flowcharts, layouts, sample runs, technical notes, and personnel to contact for assistance. For the reader with access to the AFHRL Sperry 1100, the reference for the computerized report contains the retrieval command which can be executed to obtain a copy of the report. Requests for documentation by other interested readers will be evaluated on an individual basis.

ADIG (Frequency Distribution Generator)

Abstract

ADIG provides a fast and efficient method of distributing information on a file. ADIG is actually a program generator that will accept minimal control information, automatically generate internal code, and execute the created program. The ADIG frequency output file may be reported using several programs (e.g., FFPRT, CTAB, ONEWAY). (AFHRL/TSCS)

Program Documentation

AFHRL/TSCS. ADIG. An AFHRL Sperry 1100 document processor report. Report retrieval command: @S*S.DOC ADIG

AID-4 (Automatic Interaction Detector)

Abstract

AID 4 is a computer program written primarily in FORTRAN and adapted from an earlier program (Sonquist & Morgan, 1964) obtained from the University of Michigan. It is useful in the identification of interactions among predictor variables and is essentially a model identification process for multiple linear regression analysis. The basic idea of the AID-4 algorithm is to explain the variance of the criterion variable by the sequential splitting of the original group into subgroups. The splitting is done in such a way as to minimize the within-groups (error) sum of squares. This is accomplished by the examination of each possible split of every predictor variable of the current candidate group to be split and by the selection of the split giving the smallest within-groups sum of squares. Three basic statistics may be reported at each split: an R-squared value indicating the percentage of the criterion variance explained through the current iteration; an F-value indicating the significance of the reduction in the error sum of squares due to the current split; and an F-value for a one-way analysis of variance considering all groups at this iteration. AID-4 will handle up to 300 predictor variables which may be either categorical or continuous. The maximum number of recode categories for a predictor is 50. (AFHRL/MOMM)

Program Documentation

Gott, C.D., & Koplyay, J.B. (1977, July). Automatic interaction detector - version 4 (AID-4) reference manual addendum 1 (AFHRL-TR-77-30, AD-A042 968). Brooks AFB, TX: Computational Sciences Division, Air Force Human Resources Laboratory.

Koplyay, J.B., Gott, C.D., & Elton, J.H. (1973, October). Automatic interaction detector-version 4 (AID-4) reference manual (AFHRL-TR-73-17, AD-773 803). Lackland AFB, TX: Personnel Research Division, Air Force Human Resources Laboratory.

Whitehead, L.K., Koplyay, J.B., & Gott, C.D. AID-4. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC AID-4

Reference

Sonquist, J.A., & Morgan, J.N. (1964). The detection of interaction effects. Ann Arbor, MI: University of Michigan, Survey Research Center, Institute for Social Research.

ALSCAL (Alternating Least Squares Scaling)

Abstract

ALSCAL is a nonmetric (or metric) multidimensional scaling (MDS) program with a number of individual differences options. This program incorporates individual differences MDS models, multidimensional unfolding (MDU) models, nonindividual differences MDS models, and external MDS and MDU models. ALSCAL uses the alternating least squares approach to scaling proposed by Takane, Young, and de Leeuw (1977), as improved by Young, Takane, and Lewyckyj (1978). ALSCAL is suitable for any type of two- or three-way data (rectangular or square, symmetric or asymmetric, conditional or unconditional, replicated or unreplicated, with or without missing data) which may be measured at the nominal, ordinal, interval, or ratio level of measurement (or may be binary). ALSCAL permits the analysis of multiple matrices in as many as six dimensions. (AFHRL/MOMM)

Program Documentation

Phalen, W.J., & Whitehead, L.K. ALSCAL. An AFHRL SPERRY 1100 document processor report. Report retrieval command: @DA*DA.ADOC ALSCAL

Young, F.W., & Lewyckyj, R. (1979). ALSCAL-4 users guide (2d ed.). Chapel Hill, NC: University of North Carolina, Data Analysis and Theory Associates.

References

Takane, Y., Young, F.W., & de Leeuw, J. (1977). Nonmetric individual differences multidimensional scaling: An alternating least squares method with optimal scaling features. Psychometrika, 42, 7-67.

Young, F.W., Takane, Y., & Lewyckyj, R. (1978). Three notes on ALSCAL. Psychometrika, 43, 433-435.

ANOVA-UNEQ (Unequal N Analysis of Variance)

Abstract

ANOVA-UNEQ performs one- or two-way analysis of variance for experimental data having unequal (or equal) cell frequencies. The two-way analysis is carried out using an approximation procedure that yields identical F-ratios to those produced in an unweighted means analysis. In

addition to the customary computations, a chi-square value can be computed for Bartlett's homogeneity of variance test and, in the one-way analysis of variance, an omega-square strength of association value can be reported. A Duncan multiple range test for investigation of the differences between all pairs of cell means can also be performed. ANOVA-UNEQ will not perform an analysis for an experiment having any empty cells or any cells with one observation only. The maximum number of groups that can be present in the analysis of variance is 20, and the maximum number of problems that can be performed on one sample is also 20. (AFHRL/MOMM)

Program Documentation

Black, D.E., Whitehead, L.K., & Koplyay, J.B. ANOVA-UNEQ. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC ANOVA-UNEQ

ASSIGN (Assignment of Cases Using the Bayesian Algorithm)

Abstract

The ASSIGN program was designed to supplement the BAYS program. It is more efficient than BAYS if the user is interested only in the following analyses: (a) forcing all items into the model, (b) using a particular subset of items, or (c) cross-validation using a previously developed model. ASSIGN requires the input of endorsement ratios from a BAYS run, a priori probabilities (user-supplied or from a BAYS run), and costs of misclassification (user-supplied or assumed). Raw data may be input from cards, an SDF file, or a COBOL file. Individual assignments may be output on cards or an SDF file. ASSIGN has the following limits: one sample, 200 items, five criterion categories, 63 categories per predictor, and 2,000 categories across all predictors. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K., & Albert, W.G. ASSIGN. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC ASSIGN

BAYS (Bayesian Method for Categorical Prediction)

Abstract

With a set of categorical predictors and a categorical criterion as input variables, the objective of the analysis carried out by BAYS is to find a subset of the predictors that most effectively discriminates among the criterion categories. BAYS employs a modified version of the ABCD technique described by Moonan (1972). Bayes' formula is used to compute probabilities of class membership for each case, with the result that an individual is assigned to the criterion category for which that individual's posteriori probability is highest, or the cost of misclassification is lowest (at the option of the user).

An improvement to the ABCD technique is employed by BAYS in which a stepwise procedure in the model-building algorithm can cause variables to be eliminated after they have been added to the predictive scheme. At each stage of the model-building process, the predictive composite that is formed corresponds to the highest classification accuracy resulting from all possible additions (or deletions) of one variab e to (or from) the predictive composite existing at the previous stage. By reviewing the hit table output produced at each stage, a user can compare the

classification accuracies of the predictive composites as they are generated. Additionally, predictive composites can be evaluated in terms of misclassification costs. An assignment algorithm provides assignment information at each stage. The following options are available to the BAYS user: (a) empirical probabilities may be supplied by the user or the program will compute them from the appropriate sample(s), (b) the items may be selected so as to maximize correct classifications or minimize expected costs of misclassifications, (c) certain variables may be forced into the predictive scheme initially, and (d) the set of predictors selected may be cross-validated on up to two samples within the same run. BAYS will handle up to 200 items, five criterion categories, and three samples. Excessive computer run times can occur for problems involving large samples. The ASSIGN program is more efficient than BAYS for certain types of analyses; e.g., use of a specified model or cross-validation. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K., & Albert, W.G. BAYS. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC BAYS

Reference

Moonan, W.J. (1972). ABCD: A Bayesian technique for making discriminations with qualitative variables. Proceedings of 14th Annual Conference of the Military Testing Association (pp. 214-245).

CANCOR (Canonical Correlation)

Abstract

The purpose of canonical analyses is to define the primary independent dimensions (basis vectors) that relate one set of variables to another set of variables. The technique is primarily descriptive, although the method involves finding sets of weights that maximize the correlation between two composite variables (one for each set of original variables). The two outputs should suggest answers to questions concerning the number of ways the two sets of measures are related, the strengths of the relationships, and the nature of the relationships so defined. CANCOR is a modification and combination of the routines in Cooley and Lohnes (1962) and Veldman (1967). The program computes a full set of canonical correlations for two sets of variables. The output contains means and standard deviations for all variables, correlations between the variables, and Wilks' lambda and chi-square values for the full set of roots. Additionally, for each individual root, the program reports the chi-square value, the degrees of freedom, the significance of the chi-square value, both sets of weights, and correlations between the original and canonical variates. The program is restricted to a maximum of 50 variables per set. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. CANCOR. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC CANCOR

References

Cooley, W.W., & Lohnes, P.R. (1962). Multivariate procedures for the behavioral sciences. New York: John Wiley and Sons.

Veldman, D.J. (1967). FORTRAN programming for the behavioral sciences. New York: Holt, Rinehart and Winston.

CLUSTAR (Hierarchical Cluster Analysis)

Abstract

CLUSTAR performs hierarchical cluster analysis to define classes (clusters) of objects from measures on a set of attributes (Romesburg, 1984). The major feature of CLUSTAR is that a mixture of metric and binary scaled attributes is allowed. CLUSTAR performs hierarchical cluster analysis using the sequential paradigm described by Sneath and Sokal (1973) as follows: (a) a data matrix of measurements for each of T objects (items, individuals, etc.) over N attributes is read, (b) the data matrix is optionally standardized, (c) a (dis)similarity coefficient is used to compute a pairwise measure of (dis)similarity among the $T(T + 1)/2$ object pairs, (d) a cluster method is used to produce a tree showing the similarity/dissimilarity relationships among the T objects. Groups of objects (clusters) that are sufficiently similar to be treated as homogeneous units are defined on the tree by the user. Results from the CLUSTAR tree can then be used in the computer program CLUSTID for the classification of new objects. The program is restricted to a maximum of 250 objects and a product of T objects by N attributes not to exceed 32,000. (AFHRL/MOMM)

Program Documentation

Brown, R.H. CLUSTAR. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC CLUSTAR

Romesburg, H.C., & Marshall, K. (1984). User's manual for CLUSTAR/CLUSTID: Computer programs for hierarchical cluster analysis. Belmont, CA: Lifetime Learning Publications.

References

Romesburg, H.C. (1984). Cluster analysis for researchers. Belmont, CA: Lifetime Learning Publications.

Sneath, P.H.A., & Sokal, R.R. (1973). Numerical taxonomy. San Francisco, CA: W. H. Freeman and Co.

CLUSTID (Assign New Objects to CLUSTAR Solution)

Abstract

CLUSTID assigns "new" objects of unknown class membership into one of the classes (clusters) produced by the CLUSTAR hierarchical clustering program and assesses how well the objects fit in their assigned clusters. CLUSTID initiates the classification process by producing an augmented data matrix consisting of the data matrix input to CLUSTAR augmented by as many columns of attribute data as there are "new" objects to be classified. CLUSTID then applies many of the same subroutines as are used in CLUSTAR: CLUSTID uses the same standardization options to standardize the augmented data matrix, the same similarity or dissimilarity coefficients to transform the unstandardized or standardized augmented data matrix into a likeness matrix, the same weighting options to combine likeness matrices, and the same metric or binary linkage criteria to compute the resemblance coefficient between each "new" object and each cluster

defined by the user from the output of CLUSTAR. The output of CLUSTID is a report which shows (a) the means, standard deviations, and ranges of data for each attribute by cluster and (b) the identification of new objects into classes (clusters), together with a measure of their "fit." (AFHRL/MOMM)

Program Documentation

Brown, R.H. CLUSTID. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC CLUSTID

Romesburg, H.C., & Marshall, K. (1984). User's manual for CLUSTAR/CLUSTID: Computer programs for hierarchical cluster analysis. Belmont, CA: Lifetime Learning Publications.

Reference

Romesburg, H.C. (1984). Cluster analysis for researchers. Belmont, CA: Lifetime Learning Publications.

Sneath, P.H.A., & Sokal, R.R. (1973). Numerical taxonomy. San Francisco: W.H. Freeman and Co.

CORR (Compute and Print a Correlation Matrix)

Abstract

CORR computes and prints a correlation matrix, the minimum and maximum values, means, and standard deviations for all variables. The generated report is similar to the output from the CORR link of TRICOR. There are options for record selection, using N or N-1 in computing the standard deviation, and performing operations in double precision. (AFHRL/TSOZP)

Program Documentation

O'Hara, S.A. STATISTICS, basic statistics programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC STATISTICS

CROSS-CLAS (Cross-Classification)

Abstract

CROSS-CLAS produces cross-classifications (also called cross-tabulations or contingency tables) in two, three, or four dimensions. Row and column percentages and chi-square and Kendall's tau values may be computed for all tables if desired. A maximum of 99 problems may be executed in one run. Each problem can produce up to 80 tables from a given set of control cards and data. A given set of data may consist of a maximum of 99,999 observations, with no more than 80 variables per observation. Several options are available for recoding the data. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K., & Koplyay, J.B. CROSS-CLAS. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC CROSS-CLAS

CTAB (Cross-Tabulation Report)

Abstract

CTAB creates cross-tabulation reports depicting multidimensional frequency distributions. There are numerous options for controlling the format of the report and for producing statistical information. CTAB can compute row, column, and total percentages, means and standard deviations, average cell frequencies, median and mode of row values, and chi-square tests of independence. The only limit is that an individual two-dimensional matrix must fit into core. (AFHRL/TSOZP)

Program Documentation

O'Hara, S.A. FREQUENCY, frequency distribution programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC FREQUENCY

Reference

O'Hara, S.A. (1984). Frequency distribution system. Unpublished manuscript, Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

CURVE-FIT (Fourier-Pearson Curve Fitting)

Abstract

CURVE-FIT consists of two routines for fitting a continuous distribution to data. These routines were developed by Chisman (1968a, 1968b) at Clemson University. One routine fits a finite Fourier series to the sample points. The other routine fits each of the 12 Pearson distribution types (plus the normal distribution) to a set of data. The Fourier routine accomplishes Fourier curve fitting for up to 100 equally spaced points and will provide the user with the following: the chi-square test for goodness of fit; various tables, including a table of cumulative probabilities; an optional graph of the data points and the fitted curve; and appropriate diagnostic messages. The Pearson routine computes the parameters of each of 13 Pearson statistical distribution types from the first four moments of the data, as described in Elderton (1953). A chi-square test is provided to compare the fit of the various distribution types on a given set of data. A maximum of 100 input points is allowed, with the requirement that they be equally spaced. (AFHRL/MOMM)

Program Documentation

Black, D.E., & Whitehead, L.K. CURVE-FIT. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC CURVE-FIT

References

Chisman, J. A. (1968a). An investigation into the use of Fourier analysis in statistical curve fitting. (Engineering Experimental Station Bulletin No. 112). Clemson, SC: Clemson University, College of Engineering.

Chisman, J. A. (1968b). The Pearson generalized statistical distribution (Engineering Experimental Station Bulletin No. 111). Clemson, SC: Clemson University, College of Engineering.

Elderton, W.P. (1953). Frequency curves and correlation. London: Harren Press.

EQUIP (Equipercentile Scoring Program)

Abstract

EQUIP performs linear and equipercentile equating of two tests or composites (Angoff, 1971). The original program was obtained from St Mary's University, San Antonio, Texas, and has been modified to include a jackknifing capability (Gray & Schucany, 1972). (AFHRL/MOMM)

Program Documentation

Soria, A. EQUIP. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC EQUIP

References

Angoff, W. (1971). Scales, norms, and equivalent scores. In Thorndike (Ed.), Educational Measurement (2nd ed.). Washington, DC: The American Council on Education.

Gray, H.L., & Schucany, W.R. (1972). The generalized jackknife statistic. New York: Marcel Dekker, Inc.

FFPRT (Print à Frequency File)

Abstract

FFPRT prints frequency distributions from a mass storage frequency file created by ADIG. Free format control cards provide information for the block heading page, report titles, and selection of distributions from the frequency file. Automatic subtotaling is performed on multiway distributions. Distribution headings are taken from the automated layout for the source data file. (AFHRL/TSOZP)

Program Documentation

O'Hara, S.A. FREQUENCY, frequency distribution programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC FREQUENCY

Reference

O'Hara, S.A. (1984). Frequency distribution system. Unpublished manuscript.

FMPS (Functional Mathematical Programming System)

Abstract

FMPS is a mathematical programming system supplied by the Sperry Rand Corporation for use on the Sperry 1100. The program provides many procedures commonly used to solve linear programming problems and has the capability to solve large problems. Additionally, the program has the facility to produce user-designed optimization procedures through the use of a user-oriented control language, which resembles the FORTRAN language. (AFHRL/MOMM)

Program Documentation

Sperry Systems Reference Library. (1975). Sperry Univac 1100 series functional mathematical programming system (FMPS) programmer reference. UP-8198, Sperry Rand Corporation.

Stefancyk, P.R., Richards, W.J., & Olden, D.J. FMPS. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC FMPS

GEN-HIER-GRP (Generate HIER-GRP Input Data)

Abstract

GEN-HIER-GRP generates HIER-GRP control cards and data using the information contained on a TRICOR regression output file. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. GEN-HIER-GRP. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC GEN-HIER-GRP

GUTTMAN (Guttman Item Analysis)

Abstract

GUTTMAN is an adaptation of an item analysis program obtained from Dr. Robert Bayuk of the Research Office of the School District of Philadelphia. Guttman's technique is designed to be used with multiple-choice tests. This program uses a modified version of the Guttman weighting procedure known as the Method of Reciprocal Averages (Baker & Ragsdale, 1964). This procedure employs an interative approach in which predetermined (initial) weights for the item response categories are used as a scaling key to compute a total score for each subject. These scores and the item response categories are then used to derive a new set of item option weights, which are employed to compute total scores for each subject. This procedure may be repeated until successive sets of item option weights do not differ appreciably. The ultimate set of weights maximizes the internal consistency index of test reliability for the group of subjects on that instrument. Iterative output includes the new item option weights, mean squares for error and subject variance, Hoyt's internal consistency coefficient, optional tables of the difference between sets of weights on successive iterations, and optional validity coefficients between the external and/or internal criterion and the iteration scores. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K., & Ree, M.J. GUTTMAN. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC GUTTMAN

Reference

Baker F.B., & Ragsdale, R. (1964). The method of reciprocal averages for scaling of inventories and questionnaires. Unpublished manuscript.

HIER-GRP (Regression Equation Grouping)

Abstract

HIER-GRP hierarchically groups a set of regression equations so as to minimize the overall loss of predictive efficiency at each stage of clustering. The HIER-GRP program is described in Gott (1978). The mathematical procedure on which the HIER-GRP program is based is described in Bottenberg and Christal (1961). The HIER-GRP program has been used extensively for grouping regression equations in which the predictor covariance matrix and predictor means are the same for all equations being considered for grouping. This condition is called the proportionality assumption. This condition was satisfied in numerous Air Force applications of Judgment Analysis (JAN) (Christal, 1963), such as the development of enlisted promotion systems (Black, 1973; Gott, 1974). Recently, procedures have been proposed to extend the application of HIER-GRP, without program modification, to grouping analyses in more general situations (Ward, Treat, & Albert, 1984). HIER-GRP is limited to a maximum of 200 regression equations, with a maximum of 200 predictor variables per regression equation. The HIER-GRP methodology is also available on the IBM PC for problems having up to 50 regression equations and 100 predictor variables. (AFHRL/MOMM)

Program Documentation[2]

Whitehead, L.K., & Gott, C.D. HIER-GRP. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC HIER-GRP

References

Black, D.E. (1973, April). Development of the E-2 weighted airman promotion system (AFHRL-TR-73-3, AD-767 195). Lackland AFB, TX: Personnel Research Division, Air Force Human Resources Laboratory.

Bottenberg, R.A., & Christal, R.E. (1961, March). An iterative technique for clustering criteria which retains optimum predictive efficiency (WADD-TN-61-30, AD-261 615). Lackland AFB, TX: Personnel Laboratory, Wright Air Development Division.

Christal, R.E. (1963, February). JAN: A technique for analyzing group judgment (PRL-TDR-63-3, AD-403 813). Lackland AFB, TX: Personnel Research Laboratory, Aerospace Medical Division.

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[2] A users guide is being prepared for the PC version of HIER-GRP.

Gott, C.D. (1974, March). Development of the weighted airman screening system for the Air Reserve Forces (AFHRL-TR-74-18, AD-781 747). Lackland AFB, TX: Computational Sciences Division, Air Force Human Resources Laboratory.

Gott, C.D. (1978, June). HIER-GRP: A computer program for the hierarchical grouping of regression equations (AFHRL-TR-78-14, AD-A058 415). Brooks AFB, TX: Computational Sciences Division, Air Force Human Resources Laboratory.

Ward, J.H., Treat, B.R., & Albert, W.G. (1984). General applications of hierarchical grouping using the HIER-GRP program (AFHRL-TP-84-42, AD-A150 266). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

HIST (Histogram from Raw Data)

Abstract

HIST computes summary statistics from raw data and produces a histogram as a final report. The statistics reported include total observations, total valid observations, total observations out of range, total unique values, minimum and maximum values, mode, median, standard deviation, skewness, and kurtosis. (AFHRL/TSOZM)

Program Documentation

Drews, H.K. STATISTICS, basic statistics programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC STATISTICS

HITAB$ (Hit Tables for Dichotomous Criteria)

Abstract

HITAB$ supplements the TRICOR correlation and regression program by computing binary classification tables. The input files are TRICOR-predicted score files for the validation/cross-validation samples. If the cross-validation predicted scores file is used, the program will apply the "cut score" established by the validation sample scores to the cross-validation scores. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. HITAB$. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC HITAB$

IAP (Item Analysis of Achievement Tests)

Abstract

IAP is an item analysis computer program for multiple-choice achievement tests with up to 200 items. IAP makes use of the item characteristic curve and its associated parameters: X50, the ability level at which the item discriminates; and Beta, the discrimination index (Baker, 1965;

Tucker, 1946). The analyses performed by IAP enable the user (a) to choose items which have optimum discrimination power at a certain ability level, (b) to screen a certain percentage of a group of examinees, (c) to estimate the true score of an individual, and (d) to compute the probability of a correct response. The criterion on which the program bases all the statistical analyses may be either the total test score, which will be corrected for guessing if desired, or a user-specified criterion. The test may be treated either as a power test, where the analysis of each item is based on the total sample, or as a speed test, where only those individuals reaching a particular item will be considered in the analysis of that item. Options are available to correct for item/test correlation overlap and for scoring items having more than one alternative designated as the correct answer. For each item alternative, the printed output includes: the proportion of subjects choosing the alternative; mean; standard deviation; and the biserial and point-biserial correlations with statistical tests of significance for the biserial. Printed output also includes item difficulty, beta, X50, phi coefficients (optional), identification of too easy or too difficult items (as specified by the user), and plots of the item characteristic curves (optional). In addition, the user may request a factor analysis of the tetrachoric inter-item correlation matrix. (AFHRL/MOMM)

Program Documentation

Koplyay, J.B. (1981, October). Item analysis program (IAP) for achievement tests (AFHRL-TP-81-22, AD-A107 884). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Koplyay, J.B., & Whitehead, L.K. IAP. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC IAP

References

Baker, F.B. (1965). Origins of the item parameters X50 and beta as a modern item analysis technique. Journal of Educational Measurement, 2, 167-178.

Tucker, L.R. (1946). Maximum validity of a test with equivalent items. Psychometrika, 21, 1-13.

IAPG (Item Analys᠂ of Questionnaires)

Abstract

IAPG is a versatile series of item analysis computer programs. The input consists of responses to items for which the correctness or incorrectness of a particular alternative is not the same for all respondents. The comprehensive statistical/mathematical methodology that comprises IAPG enables the user to optimize the composite validity of a test instrument subject to certain restrictions described in Albert and Whitehead (1980). To facilitate hand-scoring, the composite score is computed using only unit (+1 or -1) weights for each item. The data set of responses, which is normally divided into three subsamples, can contain a maximum of five criteria. The maximum number of alternatives allowed per item is six, with values ranging from one to six inclusive. A response for a k-alternative item, where the value of k may vary from item to item, is a set of k elements where a value of plus one is assigned to the selected alternative and a value of zero is assigned to every other alternative. No more than one alternative can be selected for each item. If the number of alternatives for each item is less than six, an above-range response (the alternative selected has a value greater than six) and/or omit response (no alternative was selected) can be considered as an additional alternative. (AFHRL/MOMM)

Program Documentation

Albert, W.G., & Whitehead, L.K. (1980, August). IAPG: An item analysis program for questionnaire-type test instruments (AFHRL-TR-80-5, AD-A089 814). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Whitehead, L.K., & Albert, W.G. IAPG. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC IAPG

IAPG-HITS (Hit Table for Dichotomous Criteria)

Abstract

IAPG-HITS supplements the IAPG methodology by computing binary classification tables to measure the predictive accuracy of the composite for dichotomous criteria. The input files are the Item Selection Sequence File and the Keyed Item Response File generated by IAPG. The criterion may be either dichotomous or continuous; however, a continuous criterion will be dichotomized according to user specifications. The number of cases is limited to 2,000 per sample, and the number of items must be 400 or less. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. IAPG-HITS. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC IAPG-HITS

IREG (Interactive Regression System for Small Problems)

Abstract

IREG is an interactive regression computer package designed to be used on small problems. IREG computes means, standard deviations, and a correlation file for use in the stepwise regression segment. Using a weight file produced in the regression segment and the raw data file, the program can generate binary classification tables and cumulative frequencies for user-selected categorical variables. IREG is limited to a maximum of 30 variables and a maximum of 1,000 cases if binary classification tables are requested and 500 cases if tables of cumulative frequency counts are requested. Only SDF mass storage files can be used to input data. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K., & Ree, M.J. IREG. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC IREG

LGP (Linear Goal Programming)

Abstract

LGP was obtained from Dr. James P. Ignizio of the Pennsylvania State University. It will solve linear goal programming models (continuous variables only) by using a multiphase pivoting

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algorithm (Ignizio, 1982). Specifically, LGP allows the user to investigate conventional (single-objective) linear programming models, prioritized multiobjective models, weighted multiobjective models, fuzzy multiobjective models, and constrained regression models. Videotapes are available of a seminar conducted by Dr. Ignizio concerning formulation of the multiple-objective model, methods of solution, available software, and areas where the technique has been successfully applied. The program has the capability to solve multiple models in one run and to perform sensitivity analyses. LGP will handle problems with a maximum of 10 priority levels, 100 decision variables, and 100 rows (i. e., goals and rigid constraints). (AFHRL/MOMM)

Reference

Ignizio, J. P. (1982). Linear programming in single- and multiple-objective systems. Englewood Cliffs, NJ: Prentice-Hall, Inc.

MANOVA (Multivariate Analysis of Variance)

Abstract

MANOVA is composed of two programs, BMDX69X and X69HT, which together will solve a variety of multivariate analysis of variance and covariance problems. BMDX69X, which is a modification of the BMD program BMDX69 (Dixon, 1970), performs Model 1 multivariate analysis of variance or covariance for any hierarchical design with equal cell sizes. This includes nested, partially nested and crossed, and fully crossed designs. The design is specified by indicating the nesting relationships of the indices. Several analyses may be performed for each problem by specifying different dependent variables or covariates. X69HT reads the covariance matrices file generated by BMDX69X and computes a new multivariate analysis of variance with an error matrix generated from specified error components. Univariate tests may be performed for each dependent variable. The MANOVA packages are limited to 10 analysis of variance indices (factors) and 40 dependent variables. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K., & Albert, W.G. MANOVA. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC MANOVA

Reference

Dixon, W.J. (Ed.) (1970). BMD biomedical computer programs X-series supplement. Berkeley, CA: University of California Press.

MAPCLUS (Mathematical Programming Clustering)

Abstract

MAPCLUS is an additive, nonhierarchical clustering program which utilizes interstimulus proximities as combinations of discrete overlapping properties (Arabie & Carroll, 1980). An alternating least squares method is combined with a mathematical programming optimization procedure based on a penalty function approach to impose discrete (0,1) constraints on parameters defining cluster membership. This representation consists of a set of m (possibly overlapping) subsets or clusters, each having an associated numerical weight, $w(k)$, where $k = 1, \ldots , m$. For

any pair of stimuli, the predicted similarity is simply the sum of the weights of those subsets containing the given pair of stimuli. This procedure is supplemented by several other numerical techniques (notably a heuristically based combinatorial optimization procedure) to provide an efficient, general-purpose, computer-based algorithm for obtaining additive clustering representations. Because a satisfactory solution is often not found when the number of stimuli exceeds 30, this program is limited to a maximum of 30 stimuli. (AFHRL/MOMM)

Reference

Arabie, P., & Carroll, D.J. (1980, July). How to use MAPCLUS, a computer program for fitting the ADCLUS model. Murray Hill, NJ: Bell Laboratories.

MAX-FACTOR (Factor Analysis)

Abstract

MAX-FACTOR is a factor analysis program for problems having up to 400 variables. The power method is used to compute the factors one at a time in descending order according to the percentage of the total variance each factor explains. This feature enables the user to compute only as many factors as are required. The input consists of the upper triangular portion of a correlation matrix. The diagonal entries may be ones, in which case a principal components analysis is performed; or the diagonal entries may be user-specified estimates of the communalities (such as the largest correlation in each row of the matrix, or the squared multiple correlation obtained from the regression of each variable on the remaining variables); or the diagonal entries may be read from a file. The user may request that the program be used iteratively to improve initial estimates of the communalities. The factor loadings can be saved for subsequent use. Any subset of the factors may be rotated to a simple structure form using the varimax criterion. If desired, the factor loadings can be sorted according to absolute value. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. MAX-FACTOR. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC MAX-FACTOR

MEANSD (Mean and Standard Deviation from a Frequency File)

Abstract

MEANSD calculates the mean and standard deviation of a variable for subgroups within levels of a second variable. All calculations are performed in double-precision arithmetic. The input is a frequency file. MEANSD does not produce a printed report. It creates a file containing the following information: total observations, total valid observations, total invalid observations, total observations out of range, total unique values, minimum and maximum values, mode, median, mean, variance, standard deviation, skewness, and kurtosis. The output file may be reported by standard report writing programs such as RPT or MSDRPT. (AFHRL/TSOZM)

Program Documentation

Drew, H.K. STATISTICS, basic statistics programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC STATISTICS

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MF$ (MAX-FACTOR Score Generator)

Abstract

Using raw data and factor loadings (original or rotated) from a MAX-FACTOR file, MF$ computes factor scores (Harman, 1968). The factor scores may be output on a file and/or printed. The program is limited to a maximum of 400 variables and 200 factors. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. MF$. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC MF$

Reference

Harman, H.H. (1968). Modern factor analysis. Chicago, IL: University of Chicago Press.

MSDRPT (Print MEANSD Output)

Abstract

MSDRPT produces a listing of the output records from MEANSD containing the following information: distribution identifier, major field value, total valid observations, total invalid observations, minimum and maximum values, mode, median, mean, and standard deviation. (AFHRL/TSOZM)

Program Documentation

Drews, H.K. STATISTICS, basic statistics programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC STATISTICS

MULT-DISCR (Multiple Discriminant Analysis)

Abstract

MULT-DISCR is a major modification of DISCRM (Veldman, 1967). The program has an option to compute the amount of core required for a particular multiple discriminant analysis problem so the user may determine whether the problem may be run. Output from the program includes: discriminant functions and tests of significance; group and total sample means, standard deviations, and correlation matrices for the original variables; correlations between the original variables and the discriminant functions; means of the scores within each group (centroids); and probabilities that individuals belong to each of the groups. For each group, a table is printed showing how the probabilities are distributed within that group. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. MULT-DISCR. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC MULT-DISCR

Reference

Veldman, D.J. (1967). FORTRAN programming for the behavioral sciences. New York: Holt, Rinehart and Winston.

MULTIVARIANCE (Multivariate Analysis of Variance)

Abstract

MULTIVARIANCE, a program purchased from National Educational Resources, Inc., can perform univariate and multivariate linear estimation and tests of hypotheses for any crossed and/or nested design where the number of observations in the subclasses may be unequal (some subclasses may be empty). The program computes an exact least squares solution using the method described by Bock (1963). The program will accept data in the following formats: (a) raw unsorted data, each observation with its own cell identification number; (b) raw data sorted by cells; (c) within group variance-covariance matrix and mean-frequency summary data; (d) raw unsorted data to be read from an independently prepared binary tape; (e) raw data grouped by subclasses to be read from an independently prepared binary tape; and (f) within group correlation matrix and mean frequency summary data. The user has access to many common data transformations. The user can provide a matrix transformation to obtain linear combinations of the original variates. At the user's option, the transformation matrix can be orthonormalized. The estimation and analysis functions of the program are based entirely on the specification of single degree-of-freedom planned contrasts. MULTIVARIANCE provides a solution for the model of deficient rank by having the user determine linear combinations of the group membership effects which are of interest. Multiple runs are necessary for testing all effects in a model where more than one error term is needed. The user may repeatedly select subsets of variables and covariates from the input data set and perform the appropriate analyses. (AFHRL/MOMM)

Program Documentation

Finn, J. D. (1978, October). MULTIVARIANCE: Univariate and multivariate analysis of variance, covariance, regression, and repeated measures - users guide (Version II, Release 2. International Standard Book No. 0-89498-003-3). Chicago, IL: International Education Services.

Reference

Bock, R.D. (1963). Programming univariate and multivariate analysis of variance. Technometrics, 5, 95-117.

MULTI-PROB (Multivariate Normal Probability)

Abstract

MULTI-PROB computes multivariate normal probabilities for up to five jointly distributed normal variables, each having a mean of zero and a variance of one. A complete description of the methodology is provided by Koplyay and Whitehead (1978). (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. MULTI-PROB. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC MULTI-PROB

Reference

Koplyay, J.K., & Whitehead, L.K. (1978). Proportions in multivariate normal distributions. Unpublished manuscript. Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

NLGP (Nonlinear Goal Programming)

Abstract

NLGP was obtained from Dr. James P. Ignizio (1982) of the Pennsylvania State University. It will solve nonlinear goal programming models using a modified Hooke-Jeeves pattern search algorithm with a ridge search. The Hooke-Jeeves algorithm performs exploratory and pattern moves to find the "best" solution to the nonlinear goal programming problem. The ridge search is employed when the pattern search can no longer find pattern or exploratory moves which improve the achievement vector. It evaluates exploratory points which are in oblique directions to the usual exploratory axes and attempts to find a resolution ridge, if it exists, and move the pattern in that direction. The ridge point becomes the new point for the renewed pattern search. NLGP allows the user to investigate conventional (single-objective) nonlinear programming models, prioritized multiobjective models of nonlinear form, and weighted multiobjective models of nonlinear form. NLGP will handle problems with a maximum of 10 priority levels, 2,500 rows (goals), and 2,500 decision variables. (AFHRL/MOMM)

Reference

Ignizio, J.P. (1982). Linear programming in single- and multiple-objective systems. Englewood Cliffs, NJ: Prentice-Hall, Inc.

ONEWAY (One-Way Frequency Distribution Print)

Abstract

ONEWAY prints one-way frequency distributions generated by ADIG. The information printed includes total valid observations, total invalid observations, percentages, mean, standard deviation, median, mode, and average cell frequency. ONEWAY reports are especially suited for the display of survey data. (AFHRL/TSOZP)

Program Documentation

O'Hara, S.A. FREQUENCY, frequency distribution programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC FREQUENCY

O'Hara, S.A. (1984). Frequency distribution system. Unpublished manuscript, Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

POLCAP (Policy Capturing)

Abstract

POLCAP simplifies the task of generating and gathering data in policy-capturing exercises conducted at AFHRL. POLCAP generates a random data sample from a truncated multivariate normal distribution with user-specified population parameters; displays profile data; collects the rankings of the policy judges; and computes a regression equation for each judge on each deck, and a hierarchical grouping analysis for each deck. POLCAP is limited to a maximum of 18 variables, 200 observations, 105 judges, and 30 decks. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. POLCAP. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC POLCAP

POLSPEC (Policy-Specifying Programs)

Abstract

Policy specifying is a decision theory methodology that was developed at AFHRL. The technique consists of the following steps: (a) identify the concept of interest and the variables that will be used to describe it, (b) select experts who will specify their policy in mathematical form, (c) define a pairwise hierarchy of the variables, and (d) specify the pairwise models. The POLSPEC programs accomplish steps (c) and (d) and are described in Ward (1977), which covers the two program packages POLSPC and PAYOFF. POLSPC will allow the user to create or modify a file that contains parameters for policy functions and to print tables of payoff values for these functions. Each policy function depends on two arguments (variables and/or functions). Multivariate functions are defined by building a chain of bivariate functions. Given the function parameters, PAYOFF will compute payoff (functional) values from the actual variables in a data file. The POLSPEC methodology is also available on the IBM PC. All programs will accommodate up to 50 functions and 50 variables. (AFHRL/MOMM)

Program Documentation[3]

Pina, M., Whitehead, L.K., & Ward, J.H. POLSPEC. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC POLSPEC

Reference

Ward, J.H. (1977, August). Creating mathematical models of judgment processes: From policy-capturing to policy-specifying (AFHRL-TR-77-47, AD-A048 983). Brooks AFB, TX: Occupation and Manpower Research Division, Air Force Human Resources Laboratory.

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[3]A users manual is being prepared for the PC version of POLSPEC.

QCORR (Quick Correlation)

Abstract

QCORR displays a correlation matrix on the terminal and can store it in double precision. The program is limited to a maximum of 14 variables. (AFHRL/TSOZP)

Program Documentation

O'Hara, S.A. STATISTICS, basic statistics programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC STATISTICS

QSTAT (Quick Statistics)

Abstract

QSTAT computes the following information in double precision on a single variable in a raw data file and displays it on the terminal: total observations, total valid observations, total invalid observations, total observations out of range, total unique values, minimum and maximum values, mode, median, mean, variance, standard deviation, skewness, and kurtosis. A histogram can also be displayed. (AFHRL/TSOZP)

Program Documentation

O'Hara, S.A. STATISTICS, basic statistics programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC STATISTICS

RANGEX (Correct Correlations for Curtailment of Range)

Abstract

RANGEX, a significant modification of RANGE (Mifflin & Verna, 1977), estimates the correlations of variables in a large, diverse population from correlations obtained from a smaller, more restricted population in which the ranges of the variables have been restricted.

The program accepts data from either cards or TRICOR files. Corrected correlation matrix output is printed and may be written as a TRICOR file. RANGEX has limits of 50 variables in the unrestricted population, 55 variables in the restricted population, and up to 50 variables difference between the two. Only linearly independent variables can be in the set of directly curtailed variables. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. RANGEX. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC RANGEX

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Reference

Mifflin, T.L., & Verna, S.M. (1977, August). A method to correct correlation coefficients for the effects of multiple curtailment (CRC-336). Arlington, VA: Center for Naval Analyses. (Prepared for the Office of Naval Research, Department of the Navy).

RUMMAGE II (Analysis of Linear Models)

Abstract

RUMMAGE II performs many types of analyses where the relationship among the variables is defined by a linear model (Bryce, 1982). The linear model may be expressed by a regression model, an analysis of variance model, or an analysis of covariance model. The design may be balanced or unbalanced. The factors may be either fixed or random and either crossed or nested. RUMMAGE II also possesses extensive residual plotting capabilities. (OTFS)

Reference

Bryce, G.R. (1982, November). Data analysis in RUMMAGE - A users guide. Provo, UT: Applied Statistics Group, Department of Statistics, Brigham Young University.

SLAM II (Simulation Language for Alternative Modeling)

Abstract

SLAM II is a FORTRAN-based, general-purpose simulation language. It permits discrete event, continuous and network modeling perspectives, or any combination of the three, to be used in developing simulation models (Pritsker & Pegden, 1979). (AFHRL/MOMD)

Reference

Pritsker, A.A.B., & Pegden, C.D. (1979). Introduction to simulation and SLAM. New York: John Wiley and Sons.

STAT (Summary Statistics from Raw Data)

Abstract

STAT computes the following summary statistics from raw data: total observations, total valid observations, total invalid observations, total observations out of range, total unique values, minimum and maximum values, mode, median, mean, variance, standard deviation, skewness, and kurtosis. A histogram can also be printed. (AFHRL/TSOZM)

Program Documentation

Drews, H.K. STATISTICS, basic statistics programs. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC STATISTICS

TRICOR (Correlation and Regression Package)

Abstract

TRICOR is a large modular program that performs a variety of statistical analysis procedures from a standard COBOL input file. TRICOR can edit a raw data file, generate and/or delete variables, compute a correlation matrix, perform stepwise regression with residual analysis (Albert, Koplyay, & Whitehead, 1982), compute F statistics for full versus restricted model tests, and compute predicted scores. The program is limited to a maximum of 400 variables. (AFHRL/TSOZ)

Program Documentation

Buchhorn, J. TRICOR. An AFHRL Sperry 1100 document processor report. Report retrieval command: @Z*ZA.DOC TRICOR

Reference

Albert, W.G., Koplyay, J.B., & Whitehead, L.K. (1982, February). REGRX: A computerized stepwise regression algorithm with residual analysis (AFHRL-TP-82-46, AD-A123 987). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

TSP (Time Series Processor)

Abstract

TSP, a computer program for econometric analysis of time series data, was developed by TSP International, Stanford, California (Hall & Hall, 1981). The package provides the following econometric techniques: ordinary least squares, two-stage least squares, three-stage least squares, least squares with autoregressive correction, weighted least squares, nonlinear least squares, and full information maximum likelihood. (AFHRL/MOMD)

Reference

Hall, B.H., & Hall, R.E. (1981). Time series processor, Version 3.5 - users manual. Stanford, CA: TSP International.

VARSEL (Variable Selection Without an External Criterion)

Abstract

VARSEL is a variable selection algorithm for use when no external criteria are present (Westphall, Mathon, McQuiston, & Greenway, 1976). Using multiple linear regression, the algorithm starts with a single item or set of items and iteratively selects items which contribute the greatest amount of unique variance to the prediction system. The selection system was designed to take into account item reliabilities when they are available. Cholesky's routine (Overall & Klett, 1972; Systems/360, 1966) is used to compute the coefficient of multiple determination. VARSEL is limited to a maximum of 400 variables. (AFHRL/MOMM)

Program Documentation

Gould, R.B., & Christal, R.E. (1976, May). VARSEL: Variable selection for multiple-purpose prediction systems in the absence of external criteria (AFHRL-TR-76-6, AD-A025 328). Lackland AFB, TX: Occupational and Manpower Research Division, Air Force Human Resources Laboratory.

References

Overall, J.E., & Klett, C.J. (1972). Applied multivariate analysis. New York: McGraw Hill.

Systems/360 Scientific Subroutine Package. (1966). (360A-CM-03X) Version III Programmers Manual. White Plains, NY: International Business Machines Corporation.

Westphall, D.N., Mathon, W.S., McQuiston, F.C., & Greenway, C.A. (1976). Source statements for VARSEL: Variable selection for multiple-purpose prediction systems in the absence of external criteria. Unpublished manuscript, Lackland AFB, TX: Computational Sciences Division, Air Force Human Resources Laboratory.

WPRIME (Residuals Test for Normality)

Abstract

WPRIME performs an approximate analysis of variance test for normality on the residuals from a regression analysis (Shapiro & Francia, 1972). The W' test is a modification of the Shapiro-Wilk W statistic for testing normality (Shapiro & Wilk, 1965) and is particularly useful for sample sizes larger than 50. Studies conducted by Shapiro, Francia, Wilk, & Chen (1968) and by AFHRL show that, for many alternative distributions, the W and W' tests have power as good or better than the following test procedures: skewness, $\sqrt{b_1}$, b_2, chi-square, Durbin, Kolmogorov-Smirnov, Cramer-Von Mises, weighted Cramer-Von Mises, and David's U. The program is limited to a maximum of 99 cases. Also, TRICOR-predicted score files are required for input. (AFHRL/MOMM)

Program Documentation

Whitehead, L.K. WPRIME. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC WPRIME

References

Shapiro, S.S., & Francia, R.S. (1972, March). An approximate analysis of variance test for normality. Journal of the American Statistical Association, 67, 215-216.

Shapiro, S.S., Francia, R.S., Wilk, M.B., & Chen, H.J. (1968, December). A comparative study of various tests for normality. Journal of the American Statistical Association, 63, 1343-72.

Shapiro, S.S., & Wilk, M.B. (1965, December). An analysis of variance test for normality (complete samples). Biometrika, 52, 591-611.

III. MATHEMATICAL AND STATISTICAL SUBROUTINE SYSTEMS

A subroutine system consists of a collection of computer subprograms, each of which carries out specific functions and adheres to a common set of conventions to ensure consistency in the programming and in the documentation for the system. Because complete computer programs, as such, are not part of a system of this type, a driver program must be prepared which calls into operation the particular series of these subroutines necessary for a given analysis. A major advantage associated with the use of subroutine systems is the greater flexibility they afford to the design of computer programs, permitting the development, with relative ease, of computer programs that are reliable and customized to the specific needs of a user.

There are four mathematical and statistical subroutine systems within the AFHRL software library: Sperry MATH-PACK, Sperry STAT-PACK, PERSUB, and IMSL. The remaining sections of this chapter give a general description of each subroutine system, along with a list of its subroutines and relevant documentation. Due to the large number of subroutines belonging to each system, descriptions of the individual subroutines are not provided in this paper. In most cases, the function of each subroutine is discernible from its name. For readers desiring more information about a specific subroutine, the documentation can be obtained from the AFHRL Technical Services Division (TS).

SPERRY MATH-PACK

General Description

The Sperry MATH-PACK system contains approximately 80 FORTRAN V mathematical subprograms. The system provides the more frequently used techniques in numerical analysis, with each subroutine designed so that the capabilities of the Sperry large-scale equipment are used efficiently (e.g., with respect to storage requirements, computational speed, and accuracy) and the program preparation required prior to calling the subroutine is minimized. The MATH-PACK subroutines are grouped into 14 general categories and are listed in the following section.

List of Subroutines

Interpolation

    GNINT (GNEXT) - Gregory-Newton interpolation (extrapolation)
    GNPOL - Gregory-Newton polynomial evaluation
    BESINT (STINT) - Bessel (Stirling) interpolation
    CDINT - Gauss central-difference interpolation
    AITINT (YLGINT) - Aitken (Lagrange) interpolation
    SPLN1 (SPLN2) - spline interpolation

Numerical Integration

    TRAPNI - trapezoidal rule
    SIM1NI (SIM3NI) - Simpson 1/3 (3/8) rule
    STEPNI - variable step integration
    GENNI - generalized numerical quadrature
    DOUBNI - double integration
    LGAUSS - Gauss quadrature abscissas and weights
    SIMPTS - Simpson 1/3 rule abscissas and weights

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Solution of Equations

NEWTIT - Newton-Raphson iteration
WEGIT (AITIT) - Wegstein (Aitken) iteration
ROOTCP - real and complex roots of a real or complex polynomial

Differentiation

DERIV1 (DERIV2) - first (second) derivative approximation
NTHDER - nth derivative of a polynomial

Polynomial Manipulation

GIVZRS - polynomial coefficients given its zeros
CVALUE - complex polynomial evaluation
POLYX (CPOLYX) - real (complex) polynomial multiplication

Matrix Manipulation: Real Matrices

MXADD (MXSUB) - matrix addition (subtraction)
MXTRN - matrix transposition
MXMLT (MXSCA) - matrix multiplication (by a scalar)
MXMDIG - matrix multiplication by diagonal matrix stored as a vector
GJR - determinant; inverse; solution of simultaneous equations
MXHOI - inverse accuracy improvement

Matrix Manipulation: Complex Matrices

CMXADD (CMXSUB) - matrix addition (subtraction)
CMXTRN - matrix transposition
CMXMLT (CMXSCA) - matrix multiplication (by a scalar)
CGJR - determinant; inverse; solution of simultaneous equations

Matrix Manipulation: Eigenvalues and Eigenvectors

TRIDMX - tridiagonalization of real symmetric matrix
EIGVAL - eigenvalues of tridiagonal matrix by Sturm sequences
EIGVEC - eigenvectors of tridiagonal matrix by Wilkinson's method

Matrix Manipulation: Miscellaneous

DGJR - double-precision determinant; inverse; solution of simultaneous equations
PMXTRI (SCALE) - polynomial matrix triangularization (scaling)
MXROT - matrix rotation

Ordinary Differential Equations

EULDE (HAMDE) - Euler's (Hamming's) method
INVAL - initial values for differential equation solution
RKDE - Runge-Kutta method
SODE - second-order equations
MRKDE - reduction of mth order system to system of m first-order equations

Systems of Equations

HJACMX (JACMX) - Jacobi iteration to determine eigenvalues and eigenvectors of Hermitian
(symmetric) matrix

LSIMEQ - solution to a set of linear simultaneous equations

NSIMEQ - functional iteration to determine solution to set of nonlinear equations

Curve Fitting

CFSRIE (DFSRIE) - coefficients of Fourier series on a continuous (discrete) range

FTRANS - Fourier transform

FITD - fitted value and derivative values for a least-squares polynomial

ORTHLS - orthogonal polynomial least-squares curve fitting

FITY - fitted values for a least-squares polynomial

COEFS - coefficients of a least-squares polynomial

Pseudo Random Number Generators

NRAND - interval (0,2**35) generator

MRAND - modified generator

RANDU - uniform distribution

RANDN (RANDEX) - normal (exponential) distribution

Specific Functions

BSSL - zero- and first-order Bessel functions

BESJ (BESY) - regular (irregular) Bessel functions of real argument

BESI (BESK) - regular (irregular) Bessel functions of imaginary argument

GAMMA - gamma function evaluation

LEGEN - Legendre polynomial evaluation

ARCTNQ - arctangent of a quotient

Documentation References

UNIVAC Systems Reference Library. (1970). UNIVAC large scale systems MATH-PACK program abstracts (UP-4051, rev. 2). Sperry Rand Corporation.

UNIVAC Systems Reference Library. (1970). UNIVAC large scale systems MATH-PACK programmers reference (UP-7542, rev. 1). Sperry Rand Corporation.

SPERRY STAT-PACK

General Description

The Sperry STAT-PACK system is comprised of 91 FORTRAN V statistical subprograms covering a wide variety of statistical techniques. Like the subprograms in the Sperry MATH-PACK system, the STAT-PACK subroutines are designed to reduce the program preparation required prior to calling a subprogram and to use the capabilities of the Sperry equipment efficiently with respect to computational speed, accuracy, and storage requirements. The STAT-PACK subroutines are grouped into 13 general statistical categories and are listed in the following section.

List of Subroutines

Descriptive Statistics

FREQP - frequency polygon
HIST - histogram
MHIST - multivariate histogram
GROUP - grouping of data

Elementary Population Statistics

AMEAN (GMEAN) - arithmetic (geometric) mean
HMEAN - harmonic mean
MEDIAN - median
MODE   - mode
QUANT - quantiles
OGIVE - distribution curve
IQRNG - interpercentile range
RANGE - range
MNDEV - mean deviation
STDEV - standard deviation
CVAR   - coefficient of variation
ORDER - order and rank statistics
CMONT (AMONT) - central (absolute) moments
CUMLT - cumulants
SHPCOR - Sheppard's corrections
KURSK - skewness and kurtosis

Distribution, Fitting, and Plotting

BINOM (POISON) - binomial (Poisson) distribution
HYPER (PNORM) - hypergeometric (normal) distribution
AFSER - Arne-Fisher series

Chi-Square Tests

CHI21S (CHI2JS) - chi-square test of sample proportion for one (J) sample(s)
CHI2P - chi-square test of fit to Poisson distribution
CHI2N (CHISAM) - chi-square test of normality (homogeneity)
CHICNT - chi-square test for independence
GENGOF - chi-square test of general goodness of fit

Significance Tests

SIGPRP - test of significance of proportion of successes
SIGMN - test of significance of a mean
SIGDMN - test of significance of the difference between two means
SIGDVR - test of significance of the ratio between two variances

Confidence Intervals

CFDMKV (CFDMUV) - confidence interval for the mean: known (unknown) variance
CFDMSU - confidence interval for the difference between two means
CFDVAR - confidence interval for variance
TOLINT - tolerance intervals

Analysis of Variance

    ANOV1/ANOV2/ANOV3 - one-way/two-way/three-way cross-classification
    MISDAT - missing data
    VTRANS - variable transformations
    ANOVRB - randomized blocks
    ANOVLS - Latin squares
    ANOVSP - split-plot design
    ANOSSP - split-split plot design
    ANOVN2 (ANOVN3) - two-way (three-way) nested design
    ANOCO   - analysis of covariance
    GLH   - general linear hypotheses

Regression Analysis

    RESTEM (REBSOM) -stepwise (back solution) multiple regression
    CORAN   - correlation analysis

Time Series Analysis

    MOVAVG - moving averages
    SEASHI - Shiskin's seasonality factors
    WEMAV - weighted moving averages
    TRELS - trend analysis by least squares
    VADIME - variate difference method
    TSFARG - autoregressive model
    GEXSMO - generalized exponential smoothing
    AUXCOR - auto-correlation and cross-correlation analysis
    POWDEN - power density functions
    RCPROB - residual probabilities

Multivariate Analysis

    GENVAR - generalized variance
    DISHOT (DSQ) - Hotelling's (Mahalanobis') distribution
    SIGTMN - significance of a set of means
    DISCRA - discriminant analysis
    FACTAN - factor and principal components analysis

Distribution Functions

    RNORM - normal distribution
    CHI   - chi-square distribution
    STUD   - Student's distribution
    FISH   - Fisher's distribution
    POIS   - Poisson distribution
    BIN   - binomial distribution
    HYGEO - hypergeometric distribution
    GAMIN - incomplete gamma distribution
    BETINC - incomplete beta distribution

Inverse Distribution Functions

    TINORM - inverse normal distribution
    STUDIN - inverse Student's distribution

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FISHIN - inverse Fisher's distribution
CHIN   - inverse chi-square distribution

Miscellaneous Subroutines

PLOT1 - plot of one line
JIM   - matrix inversion
MXTMLT - left multiplication of a matrix by its transpose

Documentation References

UNIVAC Systems Reference Library. (1969). UNIVAC 1106 system/1108 multiprocessor system STAT-PACK program abstracts (UP-4041, rev. 2). Sperry Rand Corporation.

UNIVAC Systems Reference Library. (1970). UNIVAC large scale systems STAT-PACK programmers reference (UP-7502, rev. 1). Sperry Rand Corporation.

PERSUB (Personnel Research Laboratory Subroutine) System

General Description

The PERSUB subroutine system is a set of subroutines developed during the mid-1960s at the Personnel Research Laboratory (now a part of the Air Force Human Resources Laboratory), Aerospace Medical Division, Lackland AFB, for the purpose of providing the researcher with flexibility in designing a sequence of analyses to be carried out on research data. PERSUB is written almost entirely in FORTRAN. Although the PERSUB system consists of over 70 subroutines, only those that have a mathematical or statistical function are listed below. The subroutines have been categorized into seven groups according to their function.

List of Subroutines

Description and Tabulation

GRAPH - two-dimensional graph

Matrix Algebra/Manipulation

DETERM - determinant of a symmetric positive definite matrix
EIGEN - eigenroot and eigenvector computation for a symmetric matrix
INVERS - iterative matrix inverse
MATADD - matrix addition
MATINV - matrix inverse of symmetric positive definite matrix
MATMUL - matrix multiplication
MATPOW - matrix powering
MATTRA - matrix transpose
PTRANS - computes the transformation matrix which, when premultiplied by a given matrix, transforms that matrix into an orthonormal basis
WEIGHT - add a scalar to or multiply a scalar times each element of a matrix
XTRANX - premultiplication of a matrix by its transpose

Significance Tests/Probability/Distributions

BIPROB - bivariate normal probability

BITRUN - maximum likelihood estimation of the parameters of a bivariate normal distribution from restricted samples

FSTAT - F-value associated with given degrees of freedom and probability

MUTRUN - maximum likelihood estimation of the parameters of a multivariate normal distribution from restricted samples

PENTAP - pentavariate normal probability

PLEVEL - probability level associated with given F-statistic and degrees of freedom

RANDCS - random deviate generation: chi-square distribution

RANEXP - random deviate generation: exponential distribution

RBTAFT - random deviate generation: beta, F, or t distribution

RGAMMA - random deviate generation: gamma distribution

SECANT - maximum likelihood estimation of the parameters of a normal distribution from truncated or censored samples

TETRAP - tetravariate normal probability

TRIPR - trivariate normal probability

Variance Analysis

HOMVAR - Box-Scheffé homogeneity of variance test

Correlation and Regression Analysis

AKRACY - predicted score accuracy determination

COMPAR - predicted score and actual score comparison

CORRLB - computes and prints means, standard deviations, and correlation matrix in single precision

CORRLD - computes and prints means, standard deviations, and correlation matrix in double precision

HITS   - computes a binary classification table

PRIMSC - print means, standard deviations, and correlation matrix (used by CORRLB)

PREDSC - computes predicted scores

REGRED - iterative regression, single variable correction

REGREF - iterative regression, triple variable correction (useful when highly correlated variables are present)

STDSCR - computes standardized scores

TABDEV - produces 100 binary classification tables for predicted scores ranging from 0 to 1 (.01) and the "cut score" resulting in the smallest number of misclassifications

TCFFNT - matrix of regression coefficients where the i-th column contains the regression coefficients regressing variable i on variables 1, 2, 3, . . ., i-1

Grouping or Clustering

GROUP4 - groups objects on the basis of an input matrix which contains measures of similarity or difference between all pairs of objects

Factor Analysis

COMMUN - computes communalities for a factor loadings matrix

PRAXFA - computes principal-axis factor loadings

QTRANS - square root factor analysis of a correlation matrix

VARROT - varimax rotation

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Documentation References

Ward, J. H., Jr., Buchhorn, J., & Hall, K. (1967, August). Introduction to PERSUB (PRL-TR-67-3[I], AD-660 578). Lackland AFB, TX: Personnel Research Laboratory, Aerospace Medical Division.

Ward, J. H., Jr., Hall, K., & Buchhorn, J. (1967, August). PERSUB reference manual (PRL-TR-67-3[II], AD-660 579). Lackland AFB, TX: Personnel Research Laboratory, Aerospace Medical Division.

The first reference given above (Ward, Buchhorn, & Hall, 1967) contains four examples of the application of the PERSUB system to data analysis problems. The second reference (Ward, Hall, & Buchhorn, 1967) contains descriptions of 49 PERSUB subroutines, along with a listing of the source language statements for each subroutine. Subroutines added to PERSUB after publication of the above technical reports are described in the three AFHRL Sperry 1100 document processor reports given below. The first contains descriptions of BIPROB, TRIPR, TETRAP, and PENTAP. The second contains descriptions of HOMVAR, MUTRUN, BITRUN, RANDCS, RANEXP, RBTAFT, RGAMMA, and SECANT. The third report describes AKRACY, COMMUN, COMPAR, CORRLD, HITS, PREDSC, STDSCR, and TABDEV.

Whitehead, L.K. MULTI-PROB: Multivariate normal probability. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC MULTI-PROB

Whitehead, L.K. MISC: Miscellaneous statistical subroutines. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.DOC MISC

Whitehead, L.K. PERSUB. Reference manual addendum for the Sperry 1100. An AFHRL Sperry 1100 document processor report. Report retrieval command: @DA*DA.ADOC PERSUB

IMSL System

General Description

The IMSL library contains 540 FORTRAN subroutines that were procured from IMSL, Inc., Houston, Texas, on an annual license agreement basis. These subroutines were implemented and tested on the AFHRL Sperry 1100 computer system for mathematical/statistical problem solving in support of Armed Services Vocational Aptitude Battery research. IMSL is a widely used collection of subroutines; e.g., more than 2000 sites have the software package available, the library is in use in more than 50 countries, and the package is installed on many different types of computer systems. At the expiration of the first year's lease, and each year thereafter, a cost/benefit analysis will be conducted to determine if the lease should be renewed.

List of Subroutines

Analysis of Variance

ABIBN - Analysis of balanced incomplete block and balanced lattice designs
ACRDAN (ARCBAN) - Analysis of one-way (two-way) classification design data
ACTRST - Contrast estimates and sums of squares
AFACN/AFACT - Full factorial plan analysis
AGBACP - Analysis of balanced complete experimental design structure data
AGLMOD - General linear model analysis

AGVACL - One- or two-sided interval estimate of a variance component

AGXPM - Expected mean squares for balanced complete design models

ALSQAN - Analysis of Latin square design data

AMEANS - Preparation of a set of unbalanced data for analysis by the method of unweighted
         means

ANCOV1 - Covariance analysis for one-way classification design data

ANESTE (ANESTU) - Analysis of completely nested design data with equal (unequal) numbers
                  in the subclasses

AORDR - Reordering of the data obtained from any balanced complete experimental design

ASNKMC - Student-Newman-Keuls multiple comparison test

Basic Statistics

BDCOU1 (BDCOU2) - Tally of observations into a one-way (two-way) frequency table

BDLTV - Produce letter value summary

BDTAB - Computations of frequencies of multivariate data

BDTRGI (BDTRGO) - Transgeneration of the columns of a matrix, in- (out- of-) core version

BDTWT - Computations of a two-way frequency table

BECORI (BECOR) - Estimates of means, standard deviations, and correlation coefficients,
                 in- (out- of-) core version

BECOVM (BECOVW) - Means and variance-covariance matrix (or correlation matrix from data
                  possibly containing missing observations, with weighting on option)

BECTR - Tetrachoric correlation coefficient estimation

BECVL (BECVLI) - Variances and covariances of linear functions, in- (out- of-) core version

BEGRPS - Moments estimation for grouped data with and without Sheppard's corrections

BEIGRP (BEIUGR) - Estimation of basic statistical parameters using grouped (ungrouped) data

BELBIN (BELPOS) - Interval estimate of the parameter p (lambda) of the binomial (Poisson)
                  distribution

BEMDP - Median polish of a two-way table

BEMIRI (BEMIRO) - Estimates of means, simple regression coefficients, their intercepts,
                  standard errors of the regression coefficients, and standard deviations
                  for arrays which contain missing values, in- (out- of-) core version

BEMMI (BEMMO) - Estimates of means, standard deviations, correlation coefficients, and
                 coefficients of skewness and kurtosis from a data matrix containing
                 missing observations, in- (out- of-) core version

BEMNON (BENSON) - Mean (variance) inferences using a sample from a normal population with
                  known variance (mean)

BEMSON - Mean and variance inferences using a sample from a normal population

BEPAT (BEPET) - Mean and variance inferences using samples from each of two normal
                 populations with unequal (equal) variances

BESRB - Biserial and point-biserial correlation coefficients for a qualitatively
         dichotomized variable and a numerically measurable and classified variable

BESRN - Biserial correlation coefficient for a qualitatively dichotomized variable and a
         numerically or qualitatively classified variable

BESTAT - Computations of basic univariate statistics from data possibly containing missing
         values, with weighting on option

BESTA2 - Computations of confidence intervals and other basic statistics using output from
         IMSL routine BESTAT

Categorized Data Analysis

CBNRHO - Estimation of the bivariate normal correlation coefficient using a contingency
         table

CLIFE - Life table analysis

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CTLLF   - Log-linear fit of a contingency table
CTPR   - Compute exact probabilities for contingency tables
CTRBYC - Analysis of a contingency table

Differential Equations; Quadrature; Differentiation

DBCEVL - Bicubic spline mixed partial derivative evaluator
DBCQDU - Bicubic spline quadrature
DBLIN - Numerical integration of a function of two variables
DCADRE - Numerical integration of a function using cautious adaptive Romberg extrapolation
DCSEVU - Cubic spline first and second derivative evaluator
DCSQDU - Cubic spline quadrature
DGEAR   - Differential equation solver; variable order Adams predictor corrector method or Gear's method
DMLIN   - Numerical integration of a function of several variables over a hyper-rectangle (Gaussian method)
DPDES   - Solve a system of partial differential equations of the form UT = FCN (X,T,U,UX,UXX), using the method of lines with cubic Hermite polynomials
DREBS   - Differential equation solver - extrapolation method
DRVTE   - Calculate first, second, or third derivative of a user-supplied function
DTPTB   - Solve a system of ordinary differential equations with boundary conditions at two points, using a multiple shooting method
DVCPR   - Solve a system of ordinary differential equations with boundary conditions at two points, using a variable order, variable step size finite difference method with deferred corrections
DVERK   - Differential equation solver - Runge-Kutta-Verner fifth- and sixth-order method

Eigensystem Analysis

EIGCC/EIGBS/EIGCH/EIGRF/EIGRS - Eigenvalues and (optionally) eigenvectors of a complex general/real symmetric band/complex Hermitian/real general/ real symmetric matrix
EIGZC/EIGZF - Eigenvalues and (optionally) eigenvectors of the system $A*x=lambda*B*x$ where A and B are complex/real matrices
EIGZS - Eigenvalues and (optionally) eigenvectors of the system $A*x=lambda*B*x$ where A and B are real symmetric matrices and B is positive definite
EQRT1S - Smallest or largest M eigenvalues of a symmetric tridiagonal matrix
EQRT2S - Eigenvalues and (optionally) eigenvectors of a symmetric tridiagonal matrix using the QL method
EQRT3S - Smallest (or largest) eigenvalues of a tridiagonal matrix in algebraic value whose sum exceeds a given value

Forecasting; Econometrics; Time Series; Transforms

FFTCC (FFTRC) - Compute the fast Fourier transform of a complex-(real-) valued sequence
FFTSC - Compute the sine and cosine transforms of a real-valued sequence
FFT2C - Compute the fast Fourier transform of a complex-valued sequence of length equal to a power of two
FFT3D - Compute the fast Fourier transform of a complex-valued 1, 2, or 3 dimensional array
FLINV - Inverse Laplace transform of a user-supplied complex function
FTARPS (FTMA) - Preliminary estimation of the autoregressive (moving average) parameters in an ARIMA stochastic model
FTAUTO - Mean, variance, autocovariances, autocorrelations and partial autocorrelations for a stationary time series

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FTCAST - Time series forecasts and probability limits using an ARIMA (Box-Jenkins) model

FTCP - Nonseasonal ARIMA (Box-Jenkins) stochastic model analysis for a single time series with full parameter iteration and maximum likelihood estimation

FTCROS - Means, variances, cross-covariances, and cross-correlations for two mutually stationary N channel time series

FTCRXY - Cross-covariance of two mutually stationary time series

FTFPS - Fast Fourier transform estimates of power spectra and cross-spectra of time series

FTFREQ - Single or multichannel time series analysis in the time and frequency domains

FTGEN - Generation of a time series from a given ARIMA (Box-Jenkins) stochastic model

FTKALM - Kalman filtering

FTML - Maximum likelihood estimation of autoregressive and moving average parameters in an ARIMA (Box-Jenkins) stochastic model

FTRDIF - Transformations, differences and seasonal differences of a time series for model identification

FTTR - Parameter estimates for a univariate transfer function model

FTWEIN - Wiener forecast for a stationary stochastic process

FTWENM - Multichannel Wiener forecast

FTWENX - Maximum likelihood parameter estimates for a multichannel, single output time series model

Generation and Testing of Random Numbers

GFIT - Chi-squared goodness-of-fit test

GGAMR - One-parameter gamma random deviate generator, and usable as the basis for two-parameter gamma, exponential, chi-squared, chi, beta, t, and F deviate generation

GGBN/GGBNR/GGBTR/GGCAY/GGCHS/GGEOT/GGEXN/GGHPR/GGMTN/GGNLG/GGNML/GGSTA/GGTRA/GGVCR/GGVMS/

GGWIB - Binomial/negative binomial/beta/Cauchy/chi-squared/geometric/exponential/hypergeo-metric/multinomial/log-normal/normal/stable distribution/triangular distribution/general continuous distribution/Von Mises/Weibull/random deviate generator

GGCOR - Generate a random orthogonal matrix and a random correlation matrix

GGDA (GGDT) - General discrete distribution random deviate generator using alias (table look-up) method

GGEXT - Random deviate generator for a mixture of two exponentials

GGNO (GGUO) - Generate set of order statistics from normal (uniform [0,1]) distribution

GGNPM - Normal random deviate generator via the polar method

GGNPP - Nonhomogeneous Poisson process generator with rate function lambda (t) - fixed interval, fixed number, or one-at-a-time

GGNSM - Multivariate normal random deviate generator with given covariance matrix

GGPER - Generate a random permutation of the integers 1 to k

GGPON (GGPOS) - Poisson random deviate generator where the Poisson parameter changes frequently (does not change often)

GGSPH - Generation of uniform random deviates from the surface of the unit sphere in 3 or 4 space

GGSRS - Generate a simple random sample from a finite population

GGTAB - Generate a random contingency table with given row and column totals

GGUBS - Basic uniform (0,1) pseudo-random number generator

GGUBT - Uniform (0,1) pseudo-random number generator using alternate multiplier

GGUD - Discrete uniform random number generator

GGUW - Uniform (0,1) random number generator with shuffling

GTCN - Sample size or number of class intervals determination for chi-squared test applications

GTDDU - D-square tally

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GTD2T  - The d-square test
GTMNT  - Moments and standardized moments of uniform random numbers
GTNOR  - Test for normality of random deviates
GTPBC  - Count of the number of zero bits in a given subset of a real word
GTPKP  - Probability distribution of N elements into two equiprobable states
GTPL   - Poker test tally of hand types and statistics
GTPOK  - The poker test
GTPR   - Tally of coordinates of pairs (or lagged pairs) of random numbers
GTPST  - Pairs test or Good's serial test
GTRN   - Runs test
GTRTN  - Tally of number of runs up and down
GTTRT  - Tally for triplets test
GTTT   - Triplets test
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Interpolation; Approximation; Smoothing

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IBCCCU - Bicubic spline two-dimensional coefficient calculator
IBCEVL - Evaluation of a bicubic spline
IBCIEU - Bicubic spline two-dimensional interpolator
ICSCCU - Cubic spline interpolation
ICSEVU - Evaluation of a cubic spline
ICSFKU (ICSVKU) - Least squares approximation by cubic splines - fixed (variable) knots
ICSICU - Interpolatory approximation by cubic splines with arbitrary second derivative end
            conditions
ICSMOU - One-dimensional data smoothing by error detection
ICSPLN - Cubic spline interpolation with periodic end conditions
ICSSCU/ICSSCV - Cubic spline data smoother
IFLSQ -  Least squares approximation with user-supplied functions
IQHSCU - One-dimensional quasi-cubic Hermite interpolation
IQHSCV - Smooth surface fitting with irregularly distributed data points
IRATCU - Rational weighted Chebyshev approximation of a continuous function
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Linear Algebra Equations

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LEQOF -  Linear equation solution - full matrices
LEQT1B (LEQT1F) - Linear equation solution - band (full) storage mode - space economizer
                 solution
LEQT1C - Matrix decomposition, linear equation solution - space economizer solution -
            complex matrices
LEQT1P - Linear equation solution - positive definite matrix - symmetric storage mode -
            space economizer solution
LEQT2B (LEQT2F) - Linear equation solution - band (full) storage mode - high accuracy
                 solution
LEQT2P - Linear equation solution - positive definite matrix - symmetric storage mode -
            high accuracy solution
LEQ1PB (LEQ2PB) - Linear equation solution - positive definite symmetric band matrix -
                    band symmetric storage mode - space economizer (high accuracy) solution
LEQ2C  - Linear equation solution - complex matrix - high accuracy solution
LEQ1S (LEQ2S) - Linear equation solution - indefinite matrix - symmetric storage mode -
                 space economizer (high accuracy) solution
LGINF  - Generalized inverse of a real matrix
LINV1F (LINV2F) - Inversion of a matrix - full storage mode - space economizer (high
                    accuracy) solution
LINV1P (LINV2P) - Inversion of a matrix - positive definite - symmetric storage mode -
                    space economizer (high accuracy) solution
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LINV3F - In-place inverse, equation solution, and/or determinant evaluation - full storage mode

LINV3P - In-place inverse, equation solution, positive definite matrix - symmetric storage mode

LIN1PB (LIN2PB) - Inversion of a matrix - positive definite band symmetric matrix - band symmetric storage mode - space economizer (high accuracy) solution

LLSQF (LLBQF) - Solution of a linear least squares problem

LSVDB (LSVDF) - Singular value decomposition of a bidiagonal (real) matrix

LUDATF - L-U decomposition by the Crout algorithm with optional accuracy test

LUDECP (LUDAPB) - Decomposition of a positive definite (band symmetric) matrix - (band) symmetric storage mode

LUELMF - Elimination part of the solution of Ax = B - full storage mode

LUELMP (LUELPB) - Elimination part of the solution of Ax = B - positive definite (band symmetric) matrix - (band) symmetric storage mode

LUREFF - Refinement of solution to linear equations - full storage mode

LUREFP (LUREPB) - Refinement of solution to linear equations - positive definite (band symmetric) matrix - (band) symmetric storage mode

Mathematical and Statistical Special Functions

MDBETA (MDBETI) - Beta (inverse beta) probability distribution function

MDBIN (MDBNOR) - Binomial (bivariate normal) probability distribution function

MDCH/MDCHI/MDCHN - Chi-squared/inverse chi-squared/noncentral chi-squared/probability distribution function

MDFD (MDFDRE) - F probability distribution function (integer or fractional degrees of freedom)

MDGAM (MDFI) - Gamma (inverse F) probability distribution function

MDGC (MDGCI) - General (inverse of a general) cumulative probability distribution function, given ordinates f the density

MDHYP - Hypergeometric probability distribution function

MDNOR - Normal probability distribution function

MDNRIS - Inverse standard normal probability distribution function

MDSMR - Kolmogorov-Smirnov statistics asymptotic probability distribution function

MDTD (MDSTI) - Student's t (inverse of a modification of Student's t) probability distribution function

MDTN - Noncentral t probability distribution function

MDTNF - Integral related to calculation of noncentral t and bivariate normal probability distribution functions

MDTPS - Cumulative probability and, optionally, individual terms of the Poisson probability distribution function

MERFI (MERFCI) - Inverse (complemented) error function

MERRCZ - Evaluate a function related to the complemented error function for a complex argument

MMBSIN (MMBSIR) - Modified Bessel function of the first kind of nonnegative integer (real) order for real (positive) arguments (with exponential scaling option)

MMBSIO (MMBSI1) - Modified Bessel function of the first kind of order 0 (1)

MMBSJN (MMBSJR) - Bessel function of the first kind of nonnegative integer (real) order for real (positive) arguments

MMBSJO (MMBSJ1) - Bessel function of the first kind of order 0 (1)

MMBSKR - Modified Bessel function of the second kind of nonnegative real fractional order for real positive arguments scaled by exp(arg)

MMBSKO (MMBSK1) - Modified Bessel function of the second kind of order 0 (1)

MMBZIN - Modified Bessel function of the first kind of nonnegative integer order for complex arguments

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MMBZJN (MMBSYN) - Bessel function of the first (second) kind of nonnegative integer (real fractional) order for complex (real positive) arguments

MMDAS - Dawson integral

MMDEI - Exponential integrals

MMDELK (MMDELE) - Complete elliptic integral of the first (second) kind

MMDEN - Exponential integrals of integer order for real argument x scaled by exp(x)

MMKELD - Derivatives of the Kelvin functions (ber, bei, ker, and kei) of order 0

MMKELO (MMKEL1) - Kelvin functions of the first kind (ber, bei) and of the second kind (ker, kei) of order 0 (1)

MMLINC - Elementary integral from which inverse circular functions, logarithms, or inverse hyperbolic functions may be computed

MMLINF/MMLIND/MMLINJ - Incomplete elliptic integral of the first/second/third kind

MMPSI - Logarithmic derivative of the gamma function

MMWPQ (MMWPL) - Weierstrass P-function in the equianharmonic (lemniscatic) case for complex argument with unit period parallelogram

MMWPQ1 (MMWPL1) - First derivative of the Weierstrass P-function in the equianharmonic (lemniscatic) case for complex argument with unit period parallelogram

MSENO - Expected values of normal order statistics

MSMRAT - Ratio of the ordinate to the upper tail area of the standardized normal distribution

Nonparametric Statistics

NAFRE - Friedman's test for randomized complete block designs

NAK1   - Kruskal-Wallis test for identical populations

NAWNRP - Wilson's ANOVA (2- or 3-way designs) without replicates

NAWRPE - Wilson's ANOVA (1-, 2-, 3-way designs) with equal replication

NAWRPU - Wilson's ANOVA (1-, 2-, 3-way designs) with unequal replication

NBCYC - Noether's test for cyclical trend

NBQT   - Cochran Q test

NBSDL - Cox and Stuart sign test for trends in dispersion and location

NBSIGN - Sign test (for percentiles)

NDEST - Evaluate probability density function at specified points

NDKER - Nonparametric probability density function (one-dimensional) estimation by the Kernel method

NDMPLE - Nonparametric probability density function (one-dimensional) estimation by the penalized likelihood method

NHEXT - Fisher's exact method for 2 by 2 tables

NHINC - Includance test

NKS1 (NKS2) - Kolmogorov-Smirnov one- (two-) sample test

NMCC   - Calculate and test the significance of the Kendall coefficient of concordance

NMKN   - Kendall's test for correlation (rank correlation coefficient)

NMKSF - Frequency distribution of K and the probability of equaling or exceeding K, where K, the total score from the Kendall rank correlation coefficient calculations, and N, the sample size, are given

NMKTS - K-sample trends test against ordered alternatives

NMRANK - Numerical ranking

NMTIE - Tie statistics, given a sample of observations

NRBHA - Bhapkar V test

NRWMD - Wilcoxon's signed rank test

NRWRST - Wilcoxon's rank-sum test (Mann-Whitney test)

Observation Structure; Multivariate Statistics

OCDIS - Pairwise Euclidean distances between the columns of a matrix

OCLINK - Perform a single-linkage or complete-linkage hierarchical cluster analysis given a similarity matrix

ODFISH - Linear discriminant analysis method by Fisher for reducing the number of variables

ODNORM - Multivariate normal linear discriminant analysis among several known groups

OFCOMM - Compute an unrotated factor loading matrix according to a common factor model by unweighted or generalized least squares, or by maximum likelihood procedures

OFHARR - Transformation of unrotated factor loading matrix to oblique axes by Harris-Kaiser method

OFIMAG - Compute an unrotated factor loading matrix according to an image model

OFIMA3 - Least squares solution to the matrix equation AT = B

OFPRI - Compute an unrotated factor loading matrix according to a principal components model

OFPROT - Oblique transformation of the factor loading matrix using a target matrix, including pivot and power vector options

OFRESI - Communalities and normalized factor residual correlation matrix calculation

OFROTA - Orthogonal rotation of a factor loading matrix using a generalized orthomax criterion, including quartimax, varimax, and equamax

OFSCHN - Orthogonal transformation of the factor loading matrix using a target matrix

OFSCOR - Compute a set of factor scores given the factor score coefficient matrix

OIND   - Wilk's test for the independence of K sets of multinormal variates

OPRINC - Principal components of a multivariate sample of observations

OTMLNR - Maximum likelihood estimation from grouped and/or censored normal data

Regression Analysis

RLCOMP - Generation of an orthogonal central composite design

RLDCQM - Decoding of a quadratic regression model

RLDCVA - Variance estimates for decoded orthogonal polynomial regression coefficients

RLDOPM - Coefficient decoder for an orthogonal polynomial regression model

RLEAP - Leaps and bounds algorithm for determining a number of best regression subsets from a full regression model

RLFITI (RLFITO) - Pure replication error degrees of freedom and sum of squares, in- (out-of-) core version

RLFOR - Fit a univariate curvilinear regression model using orthogonal polynomials with optional weighting (easy-to-use version)

RLFOTH (RLFOTW) - Fit a univariate curvilinear regression model using orthogonal polynomials (with weighting)

RLGQMI (RLGQMO) - Centering of independent variable settings and generation of centered (uncentered) square and cross-product terms, in- (out- of-) core version

RLINCF - Response control using a fitted simple linear regression model

RLINPF - Inverse ᵖrediction using a fitted simple linear regression model

RLLAV - Perfo. inear regression using the least absolute values criterion

RLLMV - Perform linear regression using the minimax criterion

RLMUL - Multiple linear regression analysis

RLONE - Analysis of a simple linear regression model

RLOPDC - Response prediction using an orthogonal polynomial regression model

RLPOL - Generate orthogonal polynomials with the associated constants AA and BB

RLPRDI (RLPRDO) - Confidence intervals for the true response and for the average of a set of future observations on the response, in- (out- of-) core version

RLRES - Perform a residual analysis for a fitted regression model

RLSEP - Selection of a regression model using a forward stepwise algorithm, and computation of the usual analysis of variance table entries

RLSTP - Regression model selection using a forward stepwise algorithm, with results available after each step

RLSUBM - Retrieval of a symmetric submatrix from a matrix stored in symmetric storage mode by RLSTP

RLSUM - Reordering of the rows and corresponding columns of a symmetric matrix stored in symmetric storage mode

RSMITZ - Least squares fit of the nonlinear regression model $Y(i) = alpha + beta*gamma**X(i) + e(i)$

Sampling

SSPAND (SSPBLK) - Simple (stratified) random sampling with proportional data - inferences regarding the population proportion and total

SSRAND (SSRBLK) - Simple (stratified) random sampling with continuous data - inferences regarding the population mean and total using ratio or regression estimation

SSSAND (SSSBLK) - Simple (stratified) random sampling with continuous data - inferences regarding the population mean and total

SSSCAN - Single-stage cluster sampling with continuous data - inferences regarding the population mean and total

SSSEST - Two-stage sampling with continuous data and equisized primary units - inferences regarding the population mean and total

Utility Functions

USBOX - Print a box plot (k samples)

USHHST - Print a horizontal histogram

USHST (USHST2) - Print a vertical histogram (plotting two frequencies with one bar of the histogram)

USMNMX - Determination of the minimum and maximum values of a vector

USPC - Print a sample cdf, a theoretical cdf, and confidence band information. Plot these on option.

USPDF - Plot of two sample cumulative probability distribution functions against their spectra

USPLO (USPLOD) - Printer plot of up to 10 functions (double precision)

USPRP - Probability plot

USSLF - Print a stem and leaf display

USTREE - Print a binary tree

USWBM (USWBS) - Print a matrix stored in band (band symmetric) storage mode.

USWCM (USWCH) - Print a complex (complex Hermitian) matrix stored in full (Hermitian) storage mode

USWFV (USWCV) - Print a (complex) vector

USWSM (USWFM) - Print a matrix stored in symmetric (full) storage mode.

Vector, Matrix Arithemetic

VABMXF- Maximum absolute value of the elements of a vector or a subset of the elements of a vector

VABMXS - Maximum absolute value of the elements of a row or column of a matrix stored in symmetric storage mode

VABSMF - Sum of the absolute values of the elements of a vector or a subset of a vector

VABSMS - Sum of the absolute values of the elements of a row (or column) of a matrix stored in symmetric storage mode

CAXPY (DAXPY) - Compute a constant times a vector plus a vector, all complex (double precision)

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CCOPY (DCOPY) - Copy a vector X to a vector Y, both complex (double precision)

CDOTC (CDOTU) - Compute complex dot product using conjugated (unconjugated) vector components

CSCAL (CSSCAL) - Compute a complex (real) constant times a complex vector

CSWAP - Interchange vectors X and Y, both complex

CZDOTC (CZDOTU) - Compute complex dot product using conjugated (unconjugated) vector components and double precision accumulation

DASUM - Compute double-precision sum of absolute values

DDOT - Compute double-precision dot product

DNRM2 - Compute the Euclidean length or L2 norm of a double-precision vector

DROTG (DROT) - Construct (apply) Givens plane rotation, double precision

DROTMG (DROTM) - Construct (apply) a modified Givens plane rotation, double precision

DSDOT - Compute single-precision dot product using double-precision accumulation

ICAMAX - Find the smallest index of the maximum magnitude of a complex vector

ISAMAX (IDAMAX) - Find the smallest index of the maximum magnitude of a single- (double-) precision vector

SAXPY - Compute a constant times a vector plus a vector, all single precision

SCASUM (SASUM) - Compute complex (single precision) sum of absolute values

SCNRM2 (SNRM2) - Compute the Euclidean length or L2 norm of a complex (single precision) vector

SCOPY - Copy a vector X to a vector Y, both single precision

SDOT (SDSDOT) - Compute single-precision dot product (and add a constant using double-precision accumulation)

SROTG (SROT) - Construct (apply) Givens plane rotation, single precision

SROTMG (SROTM) - Construct (apply) a modified Givens plane rotation, single precision

SSCAL (DSCAL) - Compute a single- (double-) precision constant times a single- (double-) precision vector

SSWAP (DSWAP) - Interchange vectors X and Y, both single (double) precision

VCONVO - Vector convolution

VCVTBF (VCVTFB) - Storage mode conversion of matrices, band (full) to full (band) storage mode

VCVTCH (VCVTHC) - Storage mode conversion of matrices, full complex (Hermitian) to Hermitian (full complex)

VCVTFQ (VCVTQF) - Storage mode conversion of matrices, full (band symmetric) to band symmetric (full) storage mode

VCVTFS (VCVTSF) - Storage mode conversion of matrices, full (symmetric) to symmetric (full)

VCVTQS (VCVTSQ) - Storage mode conversion of matrices, band symmetric (symmetric) to symmetric (band symmetric) storage mode

VDCPS - Decompose an integer into its prime factors

VHSH2C (VHSH2R) - Complex (real) Householder transformation to zero a single element of a matrix

VHSH3R - Real Householder transformation to zero two elements of a matrix

VHS12 - Real Householder transformation - computation and application

VIPRFF - Vector inner product of two vectors or subsets of two vectors

VIPRSS - Vector inner product of two vectors, each of which is a part of some matrix stored in symmetric mode

VMULBB (VMULFF) - Matrix multiplication, band (full) storage mode

VMULBF (VMULFB) - Matrix multiplication, band (full) by full (band) matrices

VMULBS (VMULSB) - Matrix multiplication, band (symmetric) by symmetric (band) matrices

VMULFM - Matrix multiplication of the transpose of matrix A by matrix B, full storage mode

VMULFP - Matrix multiplication of matrix A by the transpose of matrix B, full storage mode

VMULFQ (VMULQF) - Matrix multiplication, full (band symmetric) by band symmetric (full) matrices

VMULFS (VMULSF) - Matrix multiplication, full (symmetric) by symmetric (full) matrices
VMULQB - Matrix multiplication, band symmetric by band matrices
VMULQS (VMULSQ) - Matrix multiplication, band symmetric (symmetric) by symmetric (band symmetric) matrices
VMULSS (VMULQQ) - Matrix multiplication, symmetric (band symmetric) storage mode
VNRMFI - Infinity-norm matrices, full storage mode
VNRMF1 (VNRMS1) - 1-norm of matrices, full (symmetric) storage mode
VNRMF2 (VNRMS2) - Euclidean-norm of matrices, full (symmetric) storage mode
VPOLYF - Matrix polynomial, full storage mode
VSAR   - Sorting of matrices (with options)
VSODA   - Sorting of columns of a double-precision matrix in ascending order of keys in rows
VSORA   - Sorting of columns of a real matrix into ascending order of keys in rows
VSRTA (VSRTAD) - Sorting of (double-precision) arrays by algebraic value
VSRTM   - Sorting of arrays by absolute value
VSRTP (VSRTR) - Sorting of arrays by absolute (algebraic) value - permutations returned
VSRTU   - Interchange the rows or columns of a matrix using a permutation vector
VTPROF (VTPROS) - Transpose product of a matrix, full (symmetric) storage mode
VTRAN   - Transpose a rectangular matrix
VUABQ   - Matrix addition (band + band symmetric matrices)
VUAFB   - Matrix addition (full + band matrices)
VUAFQ   - Matrix addition (full + band symmetric matrices)
VUAFS   - Matrix addition (full + symmetric matrices)
VUASB   - Matrix addition (symmetric + band matrices)
VUASQ   - Matrix addition (symmetric + band symmetric matrices)

Zeros and Extrema; Linear Programming

ZANLYT - Zeros of an analytic complex function using the Muller method with deflation
ZBRENT - Zeros of a function which changes sign in a given interval (Brent algorithm)
ZCPOLY - Zeros of a polynomial with complex coefficients (Jenkins-Traub)
ZFALSE - Zero of a function given an interval containing the zero
ZPOLR - Zeros of a polynomial with real coefficients (Laguerre)
ZQADC (ZQADR) - Zeros of a quadratic with complex (real) coefficients
ZREAL1 (ZREAL2) - The real zeros of a real function - to be used when initial guesses are poor (good)
ZRPOLY - Zeros of a polynomial with real coefficients (Jenkins- Traub)
ZSCNT/ZSPOW - Solve a system of nonlinear equations
ZSRCH - Generate points in an N-dimensional space
ZXCGR - Minimum of a function of N variables using a conjugate gradient method
ZXGSN (ZXGSP) - One-dimensional unimodal function minimization using the Golden section search method (data parameters specified)
ZXLSF - One-dimensional minimization of a smooth function using safeguarded quadratic interpolation
ZXMIN - Minimum of a function of N variables using a quasi-Newton method
ZXMWD - Global minimum (with constraints) of a function of N variables
ZXSSQ - Minimum of the sum of squares of M functions in N variables using a finite difference Levenberg-Marquardt algorithm
ZXOLP - Solve the linear programming problem (phase one or phase two) via the revised simplex algorithm
ZX3LP (ZX4LP) - Solve the linear programming problem via the revised simplex algorithm, alternate easy-to-use version

Documentation References

IMSL library reference manual: Edition 9. (Vols. 1-4). IMSL LIB-0009 (rev. ed., June 1982).
Volume 1 - Chapters INTRO-D; Volume 2 - Chapters E-L; Volume 3 - Chapters M-O; Volume 4 -
Chapters R-Z. IMSL Customer Relations, 7500 Bellaire Boulevard, Houston, TX 77036.

IV. NATIONALLY RECOGNIZED STATISTICAL PACKAGES

Three widely recognized and accepted statistical packages are available in the AFHRL
mathematical and statistical software library: (a) the Biomedical Computer Programs (BMDP), (b)
STATJOB, and (c) the Statistical Package for the Social Sciences (SPSS/SPSS^X). A fourth
statistical package, the Comprehensive Occupational Data Analysis Programs (CODAP), is nationally
recognized and accepted within the occupational analysis community. Each of these packages is a
collection of computer programs that share a common main program for handling input data and for
invoking the specific procedures or programs which have been requested. Advantages of using
these packages include the similarity in the conventions for control card preparation for the
various programs in each package and the familiarity of the analytical techniques and report
formats to a wide audience of researchers. The features and specific capabilities of each of
these packages will be discussed in the following sections.

BMDP - Biomedical Computer Programs

General Description

The Biomedical Computer Programs comprise a series of statistical programs which have evolved
as a result of methodological research and programming effort at the UCLA Health Sciences
Computing Facility. The Biomedical Computer Programs were originally intended for researchers in
the health sciences, but the programs have also been used in a wide range of biological,
physical, and behavioral science applications. The Biomedical Computer programs were distributed
under the name BIMD as early as 1961. Later, the BIMD programs were consolidated and expanded
and, in 1964, were issued as BMD programs. By 1965, BMD programs were supplemented by the BMDX
programs, and in 1969, the distribution of the BMDP programs began.

The following subsections contain brief descriptions of the BMDP programs available in the
software library. The programs have been grouped together according to the following general
statistical categories: (a) data description, (b) frequency tables, (c) life tables and survival
analysis, (d) multivariate analysis, (e) regression analysis, (f) special programs, (g) time
series, and (h) analysis of variance.

Class D - Data Description

BMDP1D (Simple Data Description). P1D computes univariate statistics for each variable or
separately for each level of a grouping variable. It can list all cases or selected cases (those
containing missing values or values outside minimum or maximum limits) and store the data in a
BMDP file. Codes or intervals for a variable can be specified, and for each such variable, P1D
prints the number of cases with each code or in each interval.

BMDP2D (Detailed Data Description, Including Frequencies). P2D counts and lists distinct
values, computes univariate statistics, and plots a histogram for each variable. Values of
variables may be truncated or rounded before calculations.

BMDP3D (Comparison of Two Groups with t Tests). P3D computes one-group and two-group t tests. Two-group tests are conducted with and without the assumption of equality of variances. If there are more than two groups, the program computes two-group t tests for each pair of groups. Equality of group variances is tested by Levene's test. If several variables are analyzed, Mahalanobis' D^2 and Hotelling's T^2 can be requested.

BMDP4D (Single Column Frequencies, Numeric and Nonnumeric). P4D counts the numeric and nonnumeric characters (symbols) found in single column fields. All data are read in Al format. All keypunch characters are considered legal, and the frequency of each is counted separately.

BMDP5D (Histograms and Univariate Plots). P5D prints histograms and other univariate plots. For each plot, cases belonging to one or more groups can be used. In the plots, cases from different groups can be identified by distinct letters. The size of the plots can be specified.

BMDP6D (Bivariate Scatter Plots). P6D prints bivariate scatter plots. Cases belonging to one or more groups can be used for each plot. The regression equations for regressing each variable on the other can be requested.

BMDP7D (Description of Groups [Strata] with Histograms and Analysis of Variance). For each variable, P7D prints histograms for each group, side by side. For one-way analyses of variance, equality of group variances can be tested by Levene's test.

BMDP8D (Missing Value Correlation). P8D computes correlations four different ways from data containing missing values. Computations can be performed using (a) all acceptable values--the mean of each variable is computed from all acceptable values for that variable and then deviations from the means are used to compute covariances and correlations, (b) all acceptable pairs of values for covariances--each element of the covariance matrix is computed from the existing pairs of values involved and variances are computed using all acceptable values for each variable, (c) all acceptable pairs of values for correlations--each element of the correlation matrix is computed from the acceptable pairs of values involved, or (d) all complete cases--cases with any missing or out-of-range data are not used. Case weights may be specified.

BMDP9D (Multiway Description of Groups). P9D provides descriptive statistics of groups when the data are classified into cells by one or more grouping variables. P9D computes a chi-square test for equality of cell frequencies, a one-way ANOVA for equality of cell means, and Bartlett's test for homogeneity of variances. The program also prints a plot indicating how means shift from cell to cell.

Class F - Frequency Tables

BMDP4F (Two-Way and Multiway Frequency Tables). P4F creates multiway or cross-sections of multiway frequency tables. Tabular values can be expressed as percentages of row totals, percentages of column totals, or percentages of the total frequency. Several tests of independence and measures of association are available for two-way tables. Options are available for the development of log-linear models.

Class L - Life Tables and Survival Functions

BMDP1L (Life Tables and Survival Functions). P1L estimates the survival (time-to-occurrence) curve of subjects who have been observed over varying periods of time. Estimates are provided by the actuarial (Cutler-Ederer) life table and product-limit (Kaplan-Meier) methods. Tests of equality of the survival curves are provided by Mantel-Cox and Breslow statistics.

BMDP2L (Survival Analysis With Covariates - Cox Models). P2L analyzes Cox-style proportional hazards survival analysis models with covariates.

Class M - Multivariate Analysis

BMDP1M (Cluster Analysis of Variables). P1M clusters variables according to four measures of similarity (correlation, absolute value of the correlation, arccosine of the correlation, acute angle corresponding to the arccosine of the absolute value of the correlation) and three linkage criteria (single, complete, average).

BMDP2M (Cluster Analysis of Cases). P2M clusters cases according to four distance measures (Euclidean, sum of the pth power of the absolute difference, chi-square statistic, phi-square) and three linkage criteria (single, centroid, and k^{th} nearest neighbor).

BMDP3M (Block Clustering). P3M forms block clusters from categorical data. Block clusters correspond to submatrices of the data matrix.

BMDP4M (Factor Analysis). P4M performs factor extraction on a correlation or covariance matrix according to four methods (principal components analysis, maximum likelihood factor, Kaiser's Second Generation Little Jiffy, and principal factor analysis) and eight types of rotation (varimax, direct quartimin, quartimax, equamax, orthogonal with gamma, direct oblimin with gamma, orthoblique, and no rotation). P4M accepts input in the following forms: raw data, correlation matrix, covariance matrix, factor loadings, and factor score coefficients.

BMDP6M (Canonical Correlation Analysis). P6M performs a canonical correlation analysis for two sets of variables. It also tests for the significance of the remaining eigenvalues using Bartlett's test. P6M accepts input in the following forms: raw data, correlation matrix, and covariance matrix.

BMDP7M (Stepwise Discriminant Analysis). P7M performs a multiple group discriminant analysis using a forward or backward stepwise variable selection procedure. A jackknife-validation procedure is available.

BMDP8M (Boolean Factor Analysis). P8M performs a factor analysis on binary data utilizing Boolean matrix arithmetic. The resulting scores and factor loadings are binary.

BMDP9M (Scoring Based on Preference Pairs). P9M determines a score for each case reflecting the preferences of one or more judges. The score is derived from a linearly weighted combination of variables where the coefficients are derived from the judges comparing cases two at a time. For each comparison, the judges denote how much they prefer one case over the other.

BMDPAM (Description and Estimation of Missing Data). PAM describes the pattern of missing values and estimates missing and out-of-range values by the following four methods: substitution of mean, simple regression using the most highly correlated variable, multiple regression on a highly correlated set of variables, and regression on all variables. Three options are available for estimating the covariance and correlation matrices: all cases with valid data for both variables, maximum likelihood algorithm, and all cases with valid data for all variables.

BMDPKM (K-Means Clustering). Utilizing user-specified clusters or splitting the data into clusters, PKM assigns each case to the cluster whose center is closest to the case. The distance computed is the Euclidean distance between the mean of the cases in the cluster and the case. There are five options for standardizing the data. PKM will assign cases to clusters even if they were not used in the previous computations. Clustering assignments can be made at intermediate clustering steps.

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Class R - Regression Analysis

BMDP1R (Multiple Linear Regression). P1R performs multiple linear regression analysis with residual analysis. If the analysis is performed on grouped data, the equality of regression lines can be tested. Regression equations can be computed with or without intercepts. Weighted least squares is an option.

BMDP2R (Stepwise Regression). P2R performs multiple linear regression analysis with residual analysis using a forward or backward stepwise variable selection procedure. Regression equations can be computed with or without intercepts. An option to force in variables is available. Variables can be grouped and considered for entry or deletion as a set. Weighted least squares is an option.

BMDP3R (Nonlinear Regression). P3R computes least squares or maximum likelihood estimates of the parameters of a nonlinear function. One of six built-in functions can be selected; otherwise, the user can specify the function and its derivatives. Upper and lower limits and linear constraints can be placed on the parameters. Weighted least squares and a residual analysis are options.

BMDP4R (Regression on Principal Components). P4R performs a stepwise regression analysis with residual analysis of a criterion on a set of principal components derived from the predictors. The magnitude of the eigenvalues or the correlations between the criterion and principal components can be used to determine the entry order of the components.

BMDP5R (Polynomial Regression). P5R computes least squares estimates of the parameters of a polynomial function in one predictor variable. Weighted least squares is an option.

BMDP6R (Partial Correlation and Multivariate Regression). P6R computes the partial correlation coefficients for pairs of variables after removing the linear effects of a set of predictor variables. The program is also useful for performing multiple linear regression analyses with multiple criteria. Weighted least squares is an option.

BMDP9R (All Possible Subsets Regression). P9R uses the Furnival-Wilson algorithm to identify the "best" subset of m variables in a regression. The following three measures of "best" are available: squared multiple correlation coefficient, adjusted squared multiple correlation coefficient, and Mallows' C_p. Weighted least squares, a residual analysis, and no-intercept models are options.

BMDPAR (Derivative-Free Nonlinear Regression). PAR computes least squares of maximum likelihood estimates of the parameters of a nonlinear function when the derivatives of the function are difficult to specify or compute. Upper and lower limits can be placed on the parameters or linear combinations of the parameters. Weighted least squares and a residual analysis are options.

BMDPLR (Stepwise Logistic Regression). PLR computes maximum likelihood estimates of the parameters of a linear logistic function. The stepwise variable selection procedure can be performed in a forward or backward manner.

Class S - Special Programs

BMDP1S (Multipass Transformation). P1S performs multiple passes of the data which can be useful for transforming or editing the data.

BMDP3S (Nonparametric Statistics). P3S computes the sign test, Wilcoxin signed-rank test, Mann-Whitney rank-sum test, Kruskal-Wallis one-way analysis of variance, Friedman two-way analysis of variance, Kendail's coefficient of concordance, and the Kendall and Spearman rank correlation coefficient.

Class T - Time Series Analysis

BMDP1T (Univariate and Bivariate Spectral Analysis). Given a time series or pair of time series, P1T splits each time series into a sum of sine waves at different frequencies with a different amplitude and phase at each frequency. The program furnishes univariate summary statistics and provides extensive plotting options.

BMDP2T (Box-Jenkins Time Series Analysis). P2T is a tool for identifying a model for time series data, estimating the parameters of the model, measuring how well the model fits the data, and forecasting future observations. P2T can handle autoregressive-integrated moving average, regression, intervention, and transfer function models.

Class V - Variance Analysis

BMDP1V (One-Way Analysis of Variance and Covariance). P1V performs a one-way analysis of variance or covariance with residual analysis. It tests whether the group means or adjusted group means are equal and whether linear contrasts of group means defined by the task scientist are equal to zero.

BMDP2V (Analysis of Variance and Covariance, Including Repeated Measures). P2V performs analyses of variance and covariance for fixed effects models and repeated measures models. The program can handle equal or unequal cell sizes.

BMDP3V (General Mixed Model Analysis of Variance). P3V uses maximum likelihood estimation to compute analyses of variance for mixed models of unbalanced design. User-specified hypotheses can be tested.

BMDP4V (Univariate and Multivariate Analysis of Variance and Covariance, Including Repeated Measures). P4V performs univariate and multivariate analyses of variance and covariance. The program can handle equal or unequal cell sizes, cell weighting, and repeated measures designs.

BMDP8V (General Mixed Model Analysis of Variance - Equal Cell Sizes). P8V performs analyses of variance for mixed models with equal cell sizes. The Cornfield and Tukey method is used to define expected mean squares.

Documentation References

Dixon, W.J., & Brown, M. B. (Eds.). (1977). BMDP-77 biomedical computer programs, P-series. Berkeley: University of California Press.

Dixon, W.J., & Brown, M.B. (Eds.). (1979). BMDP-79 biomedical computer programs, P-series. Berkeley: University of California Press.

Dixon, W.J. (1981). BMDP statistical software 1981. Berkeley, CA: University of California Press.

Dixon, W.J. (1983). BMDP statistical software 1983 printing with additions). Berkeley: University of California Press.

Hill, M. (1982). BMDP user's digest (2nd ed.). Los Angeles. BMDP Statistical Software, Inc.

SPSS - Statistical Package for the Social Sciences

General Description

SPSS[X] is a system of data management/statistical programs that have been used for a wide range of applications in the social sciences area. Early developmental work on the package, then referred to as SPSS, was conducted at Stanford University. Later work on the package was accomplished at the National Opinion Research Center at the University of Chicago. The following subsections contain brief descriptions of the SPSS[X] programs available in the software library.

List of Programs and Program Descriptions

FREQUENCIES (One-Way Frequency Distributions with Descriptive Statistics). FREQUENCIES creates one-way frequency tables of counts or percentages, histograms, univariate summary statistics, and percentiles.

CONDESCRIPTIVE (Descriptive Statistics for Continuous Variables). CONDESCRIPTIVE produces univariate summary statistics for continuous variables in a more efficient manner than FREQUENCIES. This procedure also computes standardized scores (Z scores) for variables and contains options for handling missing values.

CROSSTABS (Contingency Tables and Related Measures of Association). CROSSTABS creates multiway frequency tables. Tabular values can be expressed as percentages of row totals, percentages of column totals, or percentages of the total frequency. This procedure also computes expected frequencies and residuals for each cell, tests of independence, and measures of association.

MULT RESPONSE (One-Way and Multiway Frequency Tables). MULT RESPONSE creates one-way and multiway frequency tables for the analysis of multiple response items. Tabular values for the multiway tables can be expressed as percentages of row totals, percentages of column totals, or percentages of total frequency. This procedure also contains options for handling missing values.

BREAKDOWN (Summary Statistics for Subpopulations). BREAKDOWN computes univariate summary statistics for a criterion for various subpopulations defined by one or more predictor variables, a one-way analysis of variance, and a test of linearity. This procedure also contains options for handling missing values.

REPORT (Report Generator). REPORT furnishes the user with flexibility in controlling the format for displaying case listings, univariate summary statistics in the population and subpopulations, and frequency tables. Specifically, REPORT allows the user to control page lengths, margins, column widths, vertical spacing, page titles, footnotes, and labels for variables.

T TEST (Comparison of Sample Means). T TEST computes univariate summary statistics, Student's t, tests of the equality of group means for independent and paired samples, and a homogeneity of variances test.

ANOVA (Analysis of Variance for Factorial Designs). ANOVA performs univariate analysis of variance for factorial designs, with an option for including covariates, and tests whether group means are equal. Options are available to print cell means and a multiple classification analysis table; to use the experimental, regression, or hierarchical approaches to decompose the sums of squares; and to control the entry order of the variables.

ONEWAY (One-Way Analysis of Variance). ONEWAY performs a one-way analysis of variance, a test of trends across categories, range tests, homogeneity of variance tests, and testing of user-specified contrasts. This procedure can also compute univariate summary statistics for each group.

MANOVA (Multivariate Analysis of Variance). MANOVA performs univariate and multivariate analysis of variance and covariance for a wide range of designs. This procedure can also perform multiple regression, canonical correlation, principal components analysis, and discriminant analysis.

LOGLINEAR (Development of Log-Linear Models). LOGLINEAR develops models and performs hypothesis testing for applications where the major components are categorical variables. This procedure provides maximum likelihood estimates of the parameters, an examination of residuals, and an option for user-specified cell weights.

SCATTERGRAM (Scatter Diagram of Data Points and Simple Regression). SCATTERGRAM prints bivariate scatter plots. The regression equations for regressing each variable on the other can be requested.

PEARSON CORR (Pearson Product-Moment Correlation Coefficients). PEARSON CORR computes Pearson product-moment correlation coefficients and tests for their significance, univariate summary statistics, covariances, and cross-product deviations.

PARTIAL CORR (Partial Correlation Coefficient). PARTIAL CORR computes partial correlation coefficients and tests for their significance. This procedure also computes univariate summary statistics for each variable.

REGRESSION (Multiple Linear Regression Analysis). REGRESSION performs multiple linear regression analysis with residual analysis. Several variable selection techniques and regression through the origin are available, and the entry and removal criteria can be specified by the user. This procedure also computes univariate and bivariate summary statistics.

DISCRIMINANT (Discriminant Analysis). DISCRIMINANT computes a discriminant function, classifies cases, and calculates statistics to evaluate the classification results. Several variable selection techniques are available, and the entry and removal criteria can be specified by the user.

FACTOR (Principal Components/Factor Analysis). FACTOR performs a principal components analysis or a factor analysis. Several factor extraction techniques and rotations (orthogonal and oblique) are available.

NONPAR CORR (Rank-Order Correlation Coefficients. NONPAR CORR computes Spearman's rho and Kendall's tau-b rank-order correlation coefficients and tests for their significance. An option is available to select a random sample of cases.

NPAR TESTS (Nonparametric Tests). NPAR TESTS performs the following nonparametric tests: chi-square one-sample test, Kolmogorov-Smirnov one-sample test, runs test, binomial test, McNemar test, sign test, Wilcoxon matched-pairs signed-ranks test, Cochran's Q test, Friedman test, Kendall's W coefficient of concordance, two-sample median test, Mann-Whitney U test,

Kolmogorov-Smirnov two-sample test, Wald-Wolfowitz runs test, Moses test of extreme reactions, k-sample median test, and Kruskal-Wallis one-way analysis of variance test. Options are available to print univariate summary statistics and to select a random sample of cases.

BOX-JENKINS (Box-Jenkins Time Series Analysis). The BOX-JENKINS procedure is a tool for identifying a model for time series data, estimating the parameters of the model, measuring how well the model fits the data, and forecasting future observations. The observations must be equally spaced over time without missing values. Options are available to take the logarithmic or power transformation of the series and to perform seasonal or nonseasonal differencing. Autoregressive, moving average, seasonal autoregressive, and seasonal moving average parameters can be fit.

RELIABILITY (Coefficients of Reliability for Multiple-Item Scales). RELIABILITY computes coefficients of reliability for multiple-item scales using the alpha model, split model, Guttman model, parallel model, or strictly parallel model. This procedure also computes univariate and bivariate item summary statistics and performs the following analyses of variance: single-factor repeated measures design, two-way factorial design with one observation per cell, two-way randomized block design, Friedman's two-way analysis of variance on ranks, and an analysis of variance on dichotomous data.

SURVIVAL (Survival Analysis). SURVIVAL prints life tables, plots survival functions (cumulative survival distribution, probability density, and hazard rate), and performs subgroup comparisons to determine whether they have the same survival distributions.

AGGREGATE (Summary Statistics for Groups of Cases). AGGREGATE produces summary statistics for groups of cases.

Documentation References

Hull, C.H., & Nie, N.H. (1981). SPSS update 7-9 - New procedures and facilities for releases 7-9. New York: McGraw-Hill

Klecka, W.R., Nie, N.H., & Hull, C.H. (1975). SPSS primer. New York: McGraw-Hill.

Nie, N.H., Hull, C.H., Jenkins, J.G., Steinbrenner, K., & Bent, D.H. (1975). SPSS - statistical package for the social sciences - (2nd ed.). New York: McGraw-Hill.

Norusis, M.J. (1979). SPSS statistical algorithms - Release 8.0. Chicago: SPSS, Inc.

Norusis, M.J. (1982). SPSS introductory guide: Basic statistics and operations. New York: McGraw-Hill.

Norusis, M.J. (1983). SPSS^X: Introductory statistics guide. New York: McGraw-Hill.

Norusis, M.J., & Wang, C.M. (1983). SPSS^X statistical algorithms. Chicago, IL: SPSS, Inc.

SPSS^X Basics: (1984). New York: McGraw-Hill.

SPSS^X User's Guide. (1983). New York: McGraw-Hill.

STATJOB

General Description

STATJOB is a series of statistical computer programs developed at the University of Wisconsin-Madison Academic Computing Center (MACC) for use on Sperry 1100 series computers. The AFHRL mathematical and statistical software library contains Version 10 of STATJOB, which was released in 1976. The following subsections contain brief descriptions of the STATJOB programs available in the library.

List of Programs and Program Descriptions

COLFREQ1 (Single-Column Frequency Counts). COLFREQ1 performs single-column frequency counts of distinct characters.

CROSTAB2 (Data Tabulation). CROSTAB2 creates multiway frequency tables. Several tests of independence are available for two-way tables.

DISCRIM1 (Discriminant Analysis). DISCRIM1 performs a multiple group discriminant analysis using a stepwise variable selection procedure. The procedure also performs univariate analyses of variance and prints univariate and bivariate summary statistics for each group.

DSTAT2 (Descriptive Statistics and Correlation). DSTAT2 creates a correlation matrix and computes univariate summary statistics. An option is available to replace missing values with mean values; otherwise, only cases with complete data on both variables are used.

FACTOR3 (Factor Analysis). FACTOR3 performs six factor analysis techniques (principal components factoring of the correlation matrix, principal components factoring of the covariance matrix, principal factor procedure, rescaling with estimates of uniqueness, alpha, and image) and two rotations (varimax and quartimax).

NWAY1 (Analysis of Variance). NWAY1 performs univariate analyses of variance on many different types of designs. The program cannot handle data sets that have one or more missing cells. Several options are available to transform the data.

ONEWAY2 (One-Way Analysis of Variance). ONEWAY2 performs a one-way analysis of variance and several homogeneity of variance tests. It also tests whether the group means are equal and whether linear contrasts of group means specified by the task scientist are equal to zero.

PICT1 (Scatterplots, Graphs, and Tables). PICT1 produces bivariate scatter plots, graphs, and tables. The regression equations for regressing each variable on the other can be requested.

REGAN2 (Multiple Linear Regression Analysis). REGAN2 performs multiple linear regression analysis using a forward variable selection procedure.

ROTATE1 (Factor Rotation). ROTATE1 performs factor analytic rotations of a matrix of factor loadings. Several orthogonal and oblique rotations are available.

STEPREG1 (Stepwise Linear Regression Analysis). STEPREG1 performs multiple linear regression analysis using a forward or backward stepwise variable selection procedure.

TRANS1 (Data Transfer). TRANS1 sorts data in ascending or descending order or stratifies a data set based on unique values of a variable.

UNISTAT2 (Univariate Description Statistics and Histograms). UNISTAT2 computes univariate summary statistics and plots histograms.

Documentation References

The following manuals document the input/output and mathematical/statistical methodology to be used in executing and interpreting the results of the STATJOB programs.

Introduction to STATJOB, Version 10.

STATJOB summary, Version 10.

COLFREQ1. (1971, December). Single-column frequency counts.

CROSTAB2. (1975, March). Data tabulation.

DISCRIM1. (1975, March). Discriminant analysis.

DSTAT2. (1973, September). Descriptive statistics and correlation.

FACTOR3 (1974, May). Factor analysis.

NWAY1 (1971, May). NWAY1 for psychologists.

ONEWAY2. (1975, November). One-way analysis of variance.

PICT1. (1976, April). Scatterplots, graphs, and tables, second revision.

REGAN2. (1971, April). Multiple linear regression analysis.

ROTATE1. (1974, November). Factor rotation.

STEPREG1. (1973, August). Stepwise regression analysis.

TRANS1. (1974, December). Data transfer, first revision.

UNISTAT2. (1976, April). Univariate descriptive statistics and histograms.

Basis system procedures. (1970, May).

Extended system procedures. (1972, February).

STJBANK procedures. (1974, October).

Transformation procedures. (1975, October).

General Description

ASCII CODAP is a package of computer programs used to input, process, organize, and report occupational data from job inventories. CODAP was developed by the AFHRL in the 1960s and contains over 50 ASCII FORTRAN computer programs. The current AFHRL package can process 20,000 cases, 3,000 task ratings per case, and 1,000 items of background information per case. Hierarchical clustering can be performed on up to 7,000 cases. The CODAP system contains seven basic types of programs: data quality control, sample identification and selection, individual and group summary report, individual and group comparison, task factor and task module, cluster analysis, and standard statistical analysis.

CODAP manipulates and reports task-level and biographical survey data gathered from job incumbents and expert raters for the purpose of identifying and analyzing current job structures and task characteristics within an occupational area. In this context, a "job" consists of the set of tasks a job incumbent has selected from a job survey instrument and rated on a "relative time spent" scale to reflect the work the individual actually performs. When individual job descriptions are consolidated and averaged, group job descriptions are produced. Group job descriptions may consist of job incumbents who responded similarly to one or more biographical items, such as skill or grade level, or who responded similarly in terms of tasks performed, as determined by the hierarchical clustering of jobs. Jobs can also be described in terms of task characteristics, such as task learning difficulty, strength and stamina requirements, or recommended training emphasis. Task characteristics are derived from the pooled task ratings of expert raters who are senior members of the occupational area surveyed. CODAP procedures focus on the analysis and comparison of individual and group job descriptions and their associated biographical data, as well as on individual tasks and task modules and their associated characteristics.

CODAP was initially designed to provide a data-based approach for evaluating and updating Air Force enlisted classification structures and redesigning jobs. CODAP has been extended to officer and civilian occupational classifications. The greatest payoff in the use of CODAP has been in training, where CODAP has provided data that have been instrumental in eliminating unnecessary training and in pinpointing specific training requirements. CODAP has also contributed significantly to the resolution of problems in the areas of personnel utilization, skills management, manpower requirements, aptitude requirements, job evaluation, and person-job match.

List of Programs and Program Descriptions

ASFACT (Reporting Secondary Factor Data). ASFACT reports the following information on each task for any group of individuals whose job description has been computed by JOBSPC or JOBGRP: frequency distribution of responses (0 to 9 scale), number of responses within and outside the specified range, and mean and standard deviation of acceptable responses.

AUTOJT (Automated Job Typing). AUTOJT evaluates between-group differences for pairs of Job Descriptions to aid in determining distinct job types within the hierarchical clustering process. Six comparisons are computed and reported for each pair of job descriptions. These include differences in percent time spent on each task, percent time spent on each duty, percent members performing each task, number of tasks needed to account for a specified percent of total group time, and average number of tasks performed by each group.

AVALUE (Average Value for Each Task). AVALUE computes an average value for each task in the job inventory based on a selected variable for all cases who perform that task. For example, this program might be used to compute the average grade level of the members performing each task.

AVGPCT (Average Value by Percent Performing). AVGPCT computes an average value for each task in the job inventory based on the percent of members performing the task at each level of the selected variable. In other words, the average will be adjusted to account for unequal membership within each interval.

CODAPI (Interface to Input Data to CODAP). CODAPI provides an interface with other data analysis packages. It takes a COBOL-format file and creates CODAP-compatible data cards.

CODAPX (Interface to Extract Data from CODAP). CODAPX provides an interface with other data analysis packages. It takes a CODAP History or KPATH file and creates a COBOL-format file.

COMGEN (Composite Factor Generator). COMGEN allows the user to generate a special FORTRAN program to perform operations on vectors from the Job Description file and produce new composite task factors.

CORREG (Correlation and Regression of Case Variables). This program extracts up to 100 background and computed variables from a CODAP History or KPATH file, computes a correlation matrix, and generates solutions to specified regression problems. The correlation part computes and prints the correlation matrix, number of valid cases in the sample, and means and standard deviations of the sample. A series of regression problems may be solved using an iterative technique. The standard and raw score weights for each variable are reported, as well as the regression constants.

CORSET (Core Task Analysis and Comparison Program). This program analyzes and compares a set of group job descriptions ("contextual" groups) in terms of number of core tasks performed, percent members performing and time spent on each core task, and the ability of each core task to discriminate each group from all other groups in the set. It also computes for each group an overall measure of within-group overlap called the "core task homogeneity index," an overall measure of between-group difference called the "index of average core task discrimination per unit of core task homogeneity," and an asymmetric measure of the extent to which each group in the set qualifies as a subgroup or supergroup of every other group in the set. If one or more groups are input to CORSET, together with a "parent" group (i.e., any larger group which subsumes them, such as the total sample group), CORSET will compute each group's complementary job description and compare the group job description with it.

CURVES (Curve Fitting and Plotting). This program finds the curve of best fit by using polynomials to predict one variable (Y) from another variable (X). CURVES can plot the curve of best fit superimposed on a scattergram of actual observations. At the end of each report, a summary is printed that includes the means and standard deviations of the input and computed variables, the correlation matrix, and a regression problem table, including RSQ, regression weights, and constant.

DIAGRM (Diagram of Clustering Process). DIAGRM generates a treelike diagram that visually displays the order in which groups were merged during the hierarchical clustering process. Each node of the tree represents one stage of the clustering process and displays the number of members clustered at that stage, the KPATH range defining the cluster membership, the average overlap between the two groups merging at that stage, and the average overlap within the combined group.

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DICTXX (Print Variable Dictionary). DICTXX will provide the user with a list of variable titles and their respective formats, as defined on the History or KPATH file.

DIST2X (Two-Way Distribution). DIST2X computes and reports a cross-tabulation of values for two variables, either computed or background, for specified cases. In addition to cell frequencies, percentages of row, column, and/or total sample frequencies, as well as row and column means and standard deviations, may be displayed. An additional row or column labeled "OTHER" may be added to account for values outside the specified limits.

DUVARS (Compute Duty Variables). For each individual case, DUVARS computes the total percent time spent in each duty, the number of tasks performed in each duty, and/or the percent of an individual's responses which are performed in each duty. The computations may be stored as new background variables on the History or KPATH file.

EXTRCT (Reprinting of Reports). EXTRCT will reprint any report or group of reports saved on the CODAP Report file during an analysis.

FACCOR (Correlation and Regression of Task Factors). FACCOR will extract up to 100 vectors of task values (task factors) on the CODAP FACSET file and compute correlation matrices and regression problems. The computations and reports are like those of CORREG.

FACEXT (Factor Extract). FACEXT will extract up to 100 vectors of task values (i. e., task factors) on the CODAP FACSET file and write them to a COBOL file. The purpose of this program is to establish an interface to other statistical packages available outside CODAP.

FACGEN (Factor Generator). The purpose of FACGEN is to modify and/or load task factors for future processing within the CODAP system. Modifying consists of raising values to a specified power, standardizing to a mean of 5.0 and standard deviation of 1.0, or the substitution of rescaled or rank-ordered values.

FACPRE (Predicted Factors). FACPRE will apply the regression equations developed by FACCOR or CORREG and produce a task factor deck representing the predicted factor. FACPRE also provides information as to how well the predicted factor corresponds to the criterion factor.

FACPRT (Task Factor Print Program). This program allows the user to print any of the vectors on the Job Description file. In addition, the program is capable of calculating and reporting differences between vectors, maximums or minimums of sets of vectors, cumulative percentages, and categories of tasks, by using any one of six arithmetic operators. Sequential numbering and sorting of tasks, as well as the insertion of blank columns and print suppression, are under user control. If used, the suppression and category options automatically provide heading lines indicating the limitations being used. Program-identified task categories may be punched and added to the Job Description file for future reference. Reports may be produced by task, by task within duty, or by task within module.

FACSTD (Input Standard for Factor Raters). FACSTD creates the CODAP Rater History file. Its specifications are similar to those of INPSTD, except that raw task responses are stored instead of the percent time spent on tasks.

GRMBRS (Group Membership). This program produces a detailed report which describes the two groups combining at each stage of the hierarchical clustering process. The information reported includes stage numbers of merging groups, number of members in the combined group, KPATH range of the group members, number of members in each merging group, average overlap between merging groups, and average overlap within the combined group.

GROUP (Hierarchical Clustering). GROUP is the program that actually performs the hierarchical clustering in the CODAP system. At each stage, the two most similar groups are identified and combined, based on an average linkage clustering algorithm. Once combined, the similarity of this composite group with all remaining groups is reassessed. This collapsing process is continued until only one group remains. Single and complete linkage clustering algorithms are available but seldom-used options in GROUP.

GRPDIF (Compute Group Difference Descriptions). This program will compute and report the task-level differences between two job descriptions computed by JOBSPC or JOBGRP. Average percent time spent by all members or percent members performing each task is used as the basis of computation. Correlations between the average percent time spent vectors and between the percent members performing vectors may also be obtained.

GRPSUM (Summarizing Job Descriptions). GRPSUM calculates and prints a report of either the percent of members performing each task in the job inventory or the average percent time spent on each task by all members for any number of groups whose composite job descriptions were computed by JOBGRP or JOBSPC. The summarized data are printed in task number order and the group descriptions are ordered according to the sequence of the input request cards.

INPSTD (Input Standard for Job Incumbents). INPSTD creates the standard CODAP History file. This program stores percent time spent computed from raw relative time spent responses. Duty/Task title cards and History variable definitions are combined with the case data and reorganized in History file format. INPSTD will accept 20,000 cases, 3,000 task ratings, 6,000 characters of History data per case, and 26 duty categories.

JOBGRP (Compute Stage Job Descriptions). Given a stage number from the hierarchical clustering process, this program identifies all members in the group formed at that stage and computes a composite job description for those cases.

JOBIND (Print Individual Job Descriptions). This program prints a job description with specified-background information for each individual in a selected group.

JOBPRT (Job Description Print Program). This program prints job descriptions computed by JOBSPC or JOBGRP. They may be ordered by task, task within duty, or by task module.

JOBSPC (Compute Special Job Descriptions). Given the membership criteria in terms of computed or background variables, this program identifies all cases meeting these requirements and computes a composite job description for that group.

JOBSXX (Audit Job Description). JOBSXX is designed to compute and print a job description for all cases on a History or KPATH file in three different sort sequences.

KPATH (Create KPATH File). This program will resequence cases on the History file in such a way that those cases or groups of cases which merged at each stage of the hierarchical clustering process will be positioned adjacently.

MEMVAR (Create Membership Variables). This program will create dichotomous computed variables representing membership in specified groups or samples. Membership is determined by using request cards created by JOBSPC or JOBGRP.

MODSXX (Audit Module Definitions). MODSXX will print a task listing ordered by module categories. Tasks not included in any module description will be placed in a module called "Tasks Not Referenced" and printed at the end of the report.

MTXPRT (Print Overlap Matrix). This program computes the overlap between all pairs of input composite job descriptions and reports these values in matrix form. Overlap may be computed in terms of average percent time spent on tasks or in terms of the number of tasks performed in common.

OVRLAP (Overlap of Response Patterns). OVRLAP calculates the similarity between all pairs of cases on the History file. The data are arranged into a matrix format for processing by the GROUP program. History files of 7,000 cases or less may be input to this program.

PLOTIT (Plot a Task Factor Histogram). This program accepts an input task factor, defines intervals, and plots a histogram showing the frequency distribution of values.

PLTVAL (Plot Mean and Standard Deviation Values). PLTVAL is designed to produce a plot of the means and standard deviations of a background or computed variable for a set of groups computed by JOBSPC or JOBGRP.

PRIJOB (Select Primary Job Identifiers). This program prints a report of those tasks that are "primary identifiers" of each group in a set of selected groups and aligns these groups in a single report that allows across-group comparisons on each task that is a primary identifier for at least one of the groups. Primary identifiers may be defined as the top X-number of tasks in a group job description in terms of percent of members performing or average percent time spent by all members, or all tasks which meet or exceed a minimum value on one of these two percentages.

PROGEN (Program Generator). PROGEN generates a FORTRAN program from high-level commands and standard FORTRAN statements to perform various operations on the History or KPATH file. Its primary use is to add new computed or history variables to the appropriate file.

PRTVAR (Print Variable Values). PRTVAR will print the values of selected variables for all cases on the History or KPATH file. The cases can be ordered on any case variable, although KPATH order is the one most often used.

RANSEL (Random Case Selection). RANSEL will produce a membership identification vector usable as input to the program SUBSET. Given the membership vector from a job description, this program will randomly select a specified number or percentage of cases from that vector.

REXALL (Interrater Reliability). When tasks are rated by a sample of experts on task factors such as "learning difficulty" or "recommended training emphasis," REXALL is used to compute and report measures of interrater agreement (reliability) based on raw or adjusted ratings. The average intraclass correlation coefficients for a single rater and for the sample composite are reported. Also reported are the mean and standard deviation of the ratings for each task. In addition, REXALL can identify and remove divergent raters from all computations.

SETCHK (Check Sets of Raw Data Cards). SETCHK edits the raw data which will be input to the program INPSTD. Only cases with complete data are kept for further processing.

SUBSET (Create a Subset History/KPATH File). SUBSET will create a new History/KPATH file containing only those members defined by a composite job description.

TASKXX (Print Duty and Task Titles). TASKXX is designed to print a list of the duty and task titles entered in the INPSTD program.

TSKNDX (Task Index). TSKNDX computes and prints the following information for tasks performed by a selected group of members: task titles, mean rating value (Task Index), percent of members performing, average percent time spent by members performing, average percent time spent by all members, and cumulative sum of average percent time spent by all members.

VARGEN (Variable Generator). VARGEN will compute new variables for every case on the History or KPATH file based on the individual's task response data. Frequently computed variables are: average task difficulty per unit time spent (ATDPUTS) for the individual's job description, overlap of an individual's time spent with a given job description, and sum of time spent by an individual on a specified set of tasks. VARGEN can compute the sum of absolute differences, sum of squared differences, and Pearson product-moment correlation between an individual's set of task ratings and a given set of task values.

VARSUM (Variable Summary). VARSUM computes and prints frequency distributions for specified intervals, reports total frequency counts, and calculates means and standard deviations on selected background and computed variables for groups of individuals whose job descriptions have been generated by JOBSPC or JOBGRP.

VARPCT (Variable Percent Summary). VARPCT is similar to VARSUM, except that percentages are reported in place of frequency counts.

VARSXX (Variable Value Audit Distribution). VARSXX produces a listing of the raw background item or task responses made by all cases on a History or KPATH file. This output is very useful for establishing variable specifications for the VARSUM and JOBSPC programs. It is also used to audit the History file after INPSTD has been run.

Documentation References

CODAP Applications Support Section. CODAP: Comprehensive data analysis programs: An automated report. Brooks AFB, TX: Technical Services Division, Air Force Human Resources Laboratory.

The above report is in an automated form retrievable by those having access to the AFHRL SPERRY 1100/81 computer system. The report retrieval command is: @Z*CODAP.DOC. This report contains the most current CODAP documentation. Reports of individual programs may also be obtained via this command.

END
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